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Title/Author(s)

Petroleum Geochemical characterisation: Comparison of crude oils from Wells 30/9-6 and 30/9-2

By NH Research Center:

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☒ Fortrolig/Confidential ☐ Hydro-intern ☐ Åpen/Open

Resymé/konklusjon/anbefaling
Summary/Conclusion/Recommendation

- Two oils from 30/9-6 (DST 1 and 2) and one oil from 30/9-2 (DST3) have been analysed by GC, GC-MS and for stable carbon isotope contents.
- The three examined oils are geochemically similar and are believed to be derived from the same source rock system.
- The maturity of the oils are approximately the same.
- The oils are to be derived from the Viking Group shales.

Emneord/Keywords

Geochemistry, Oil-oil correlations
Biomarkers, stable carbon isotopes

Sider/Pages - Bilag/Appendix

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Divisjon/seksjon/avdeling
Division/Section/Dept.

Exploration

Kvadrant/Blokk-Brønn
Quadrant/Block-Well

30/9

Tilleggsnr./Amendment No.

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Godkj. sign./Approved sign.

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UT127/
KA 933A

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Dato/Date

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C O N T E N T

Introduction

Results and discussion

General Conclusions

Tables 1 - 3

Galimov plots

Appendix I: Chromatograms and fragmentograms.

Appendix II: High resolution mass-fragmentograms.

Introduction

Two oils from Well 30/9-6, DST 1 and DST 2 plus one from the Oseberg Alpha Stucture (30/9-2, DST 3) have been analysed for bulk properties, distribution of structured and aromatic hydrocarbons and content of certain biological marker compounds. These analysis have been undertaken for the purpose of oil - oil correlation.

Results and discussion

The bulk properties of the oils from group type separation and deasphaltening are listed in Table 1. The asphaltene content is slightly larger in the Well 30/9-2 oil relative to the two oils from Well 30/9-6. Also a slight difference exist in asphaltene content between the two 30/9-6 oils.

The content of polar compunds NSO's are very low 5-9 % and the content of saturated hydrocarbons are high, 53-60 %.

The distributions of saturated alkanes (Appendix I) are similar for the three oils which have a high content of normal paraffins.

Also distributions of aromatic hydrocarbons are similar for these oils (Appendix I).

The content of certain biological markers, steranes and triterpanes seem also similar based on visual inspection (Appendix I and II). Based on the biomarker fragmentograms have certain molecular ratios been calculated and listed in Table 2. These ratios are related either to source, maturity or combined source maturity effects.

The listed data show very little difference between the three oils as already suggested by visual inspection. However some minor differences exist.

The 30/9-6 oils are slightly different in the source parameters related to the rare C_{28} bisnorhopane C_{28}/C_{29} and C_{27}/C_{28}. Maturity parameters like %αββ, Tri/mono are similar in these two oils suggesting them to be of same thermal maturity.

The source parameters in 30/9-2, DST 3 are more like the DST 2 of Well 30/9-6. The maturity of this oil (30/9-2) appear to be slightly less then the 30/9-6 oils (e.g. Tri/mono, αββ, T_s, Dia/Reg).

However, all these differences seen are minor and it suggest that the examined oils in general terms, are of the same source rock system, expelled at about the same level of thermal maturity.

Due to presence of the rare, C_{28}, 25, 30 bisnorhopane, the oils are believed to be derived from the upper Jurassic - lower Cretaceous Viking Group shales.

The isotope data (Table 3 and Galimov plots) are in general agreement with the biomarker data. The angels of the imaginary curves through the plotted points suggest the 30/9-2 oil to be slightly less mature than the 30/9-6 oils. However, all three oils are, based on stable carbon isotope content, derived from the same source rock system, namely the Viking Group shales.

General Conclusions

- The three examined oils are geochemically very similar and are derived from the same source rock system.

- The maturity of the oils are approximately similar.

- The oils are believed to be derived from the Viking Group Shales.

Table 1. Bulk parameters from group type separations.

SAMPLE	Asph.	Sat.	ARO	NSO
30/9-6, DST 1	0,73	58	37	5
30/9-6, DST 2	1,08	53	41	6
30/9-2, DST 3	1,44	62	33	5

Table 2 Biomarker ratios of crude oils from selected structures in the study area.

	TRITERPANES				STERANES						
	Ts%	C_{28}/C_{29}	C_{27}/C_{28}	22S%	20S%	αββ%	C_{20}/C_{27}	dia/ reg.	sterane/ triterpane	sterane/ n-alkane	tri/ mono
30/9-6, DST 1	55	0.49	0.81	63	55	56	0.64	3.5	0.08	0.39	2.50
30/9-6, DST 2	55	0.55	0.69	60	54	58	0.69	3.7	0.12	0.36	2.56
30/9-2, DST 3	51	0.60	0.89	60	58	55	0.57	3.1	0.17	0.47	2.40

LEGEND TO TABLE 2

$\%T_s$:
$$\frac{C_{27}\ \text{trisnorneohopane}}{C_{27}\ \text{trisnorneohopane} + C_{27}\ \text{trisnorhopane}}$$

C_{28}/C_{29} :
$$\frac{C_{28}\ \text{bisnorhopane}}{C_{29}\ \text{norhopane}}$$

C_{27}/C_{28} :
$$\frac{C_{27}\ \text{trisnorneohopane} + C_{27}\ \text{trisnorhopane}}{C_{28}\ \text{bisnorhopane} + C_{28}\ \beta\beta\ \text{bisnorhopane}}$$

%20S :
$$\frac{C_{29}\ \alpha\alpha\alpha\ 20S\ \text{sterane}}{C_{29}\ \alpha\alpha\alpha\ 20S\ \text{sterane} + C_{29}\ \alpha\alpha\alpha\ 20R\ \text{sterane}} .100$$

$\%\alpha\beta\beta$:
$$\frac{C_{29}\ \alpha\beta\beta\ 20(R+S)}{C_{29}\ \alpha\beta\beta\ 20(R+S) + C_{29}\ \alpha\alpha\alpha\ 20(R+S)} . 100$$

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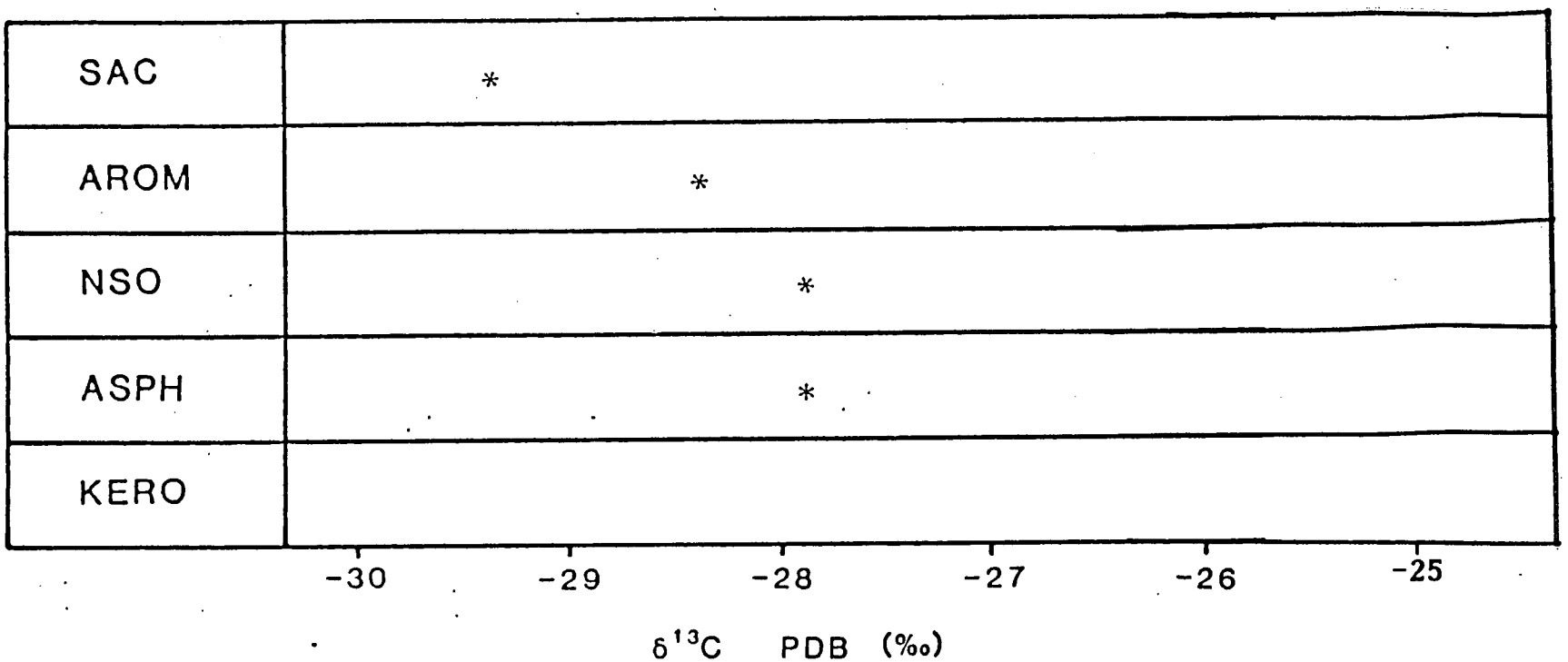
Table 3. Stable carbon isotope data of whole oils and oil fractions.

SAMPLE	Whole oil	ASPH	SAT	ARO	NSO
30/9-6, DST1	- 28.65	-27.92	- 29.27	-28.27	- 27.89
30/9-6, DST2	- 28.59	-28.00	- 29.15	-28.06	(-27.29)
30/9-2, DST3	- 28.53	-27.44	- 29.36	-28.09	- 28.45

Standards : NBS 22 = 29.61, NBS 21 = 28.13

All data are δ C values with dimension o/oo.

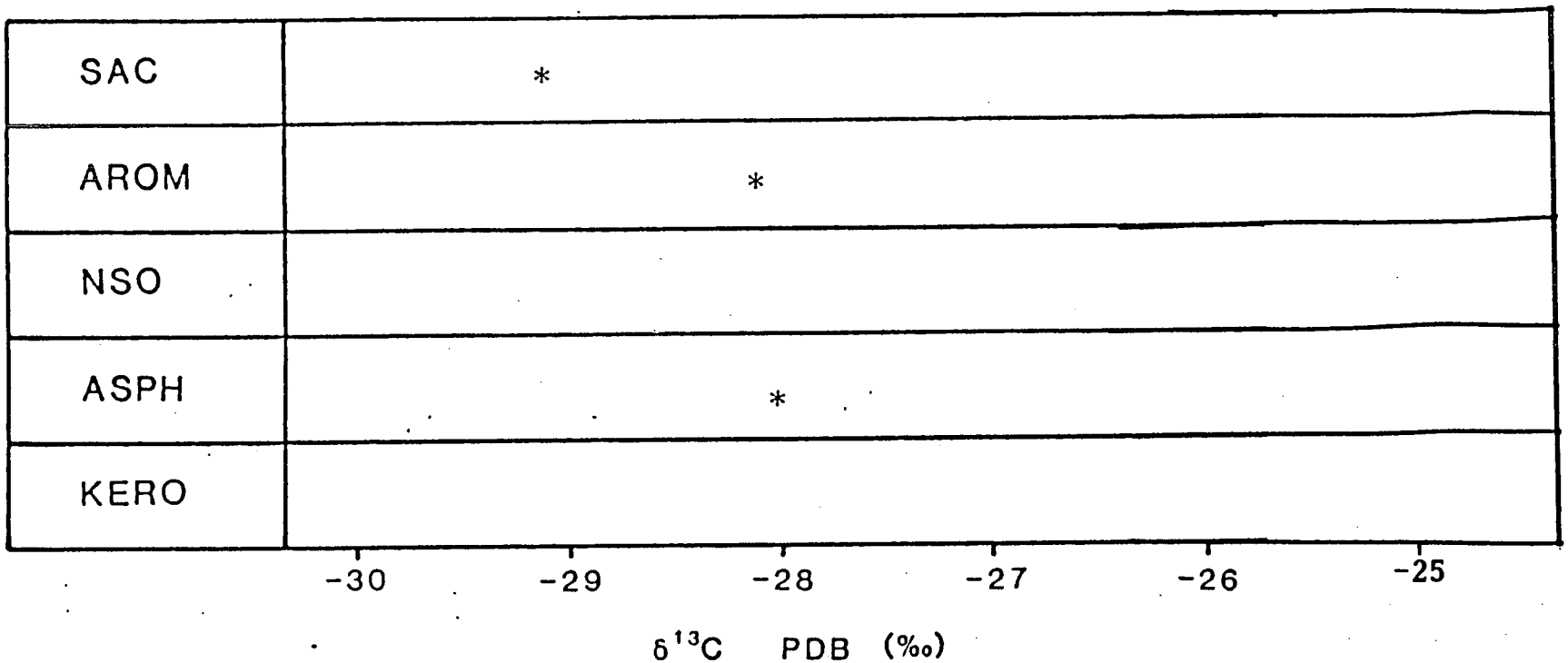
SAC : Saturated fraction
AROM : Aromatic fraction
NSO : Hetrogen fraction
ASHP : Asphaltenes



WHOLE OIL $\delta^{13}C$ = -28.65

WHOLE EXTRACT $\delta^{13}C$ =

PYROLYSATE $\delta^{13}C$ =

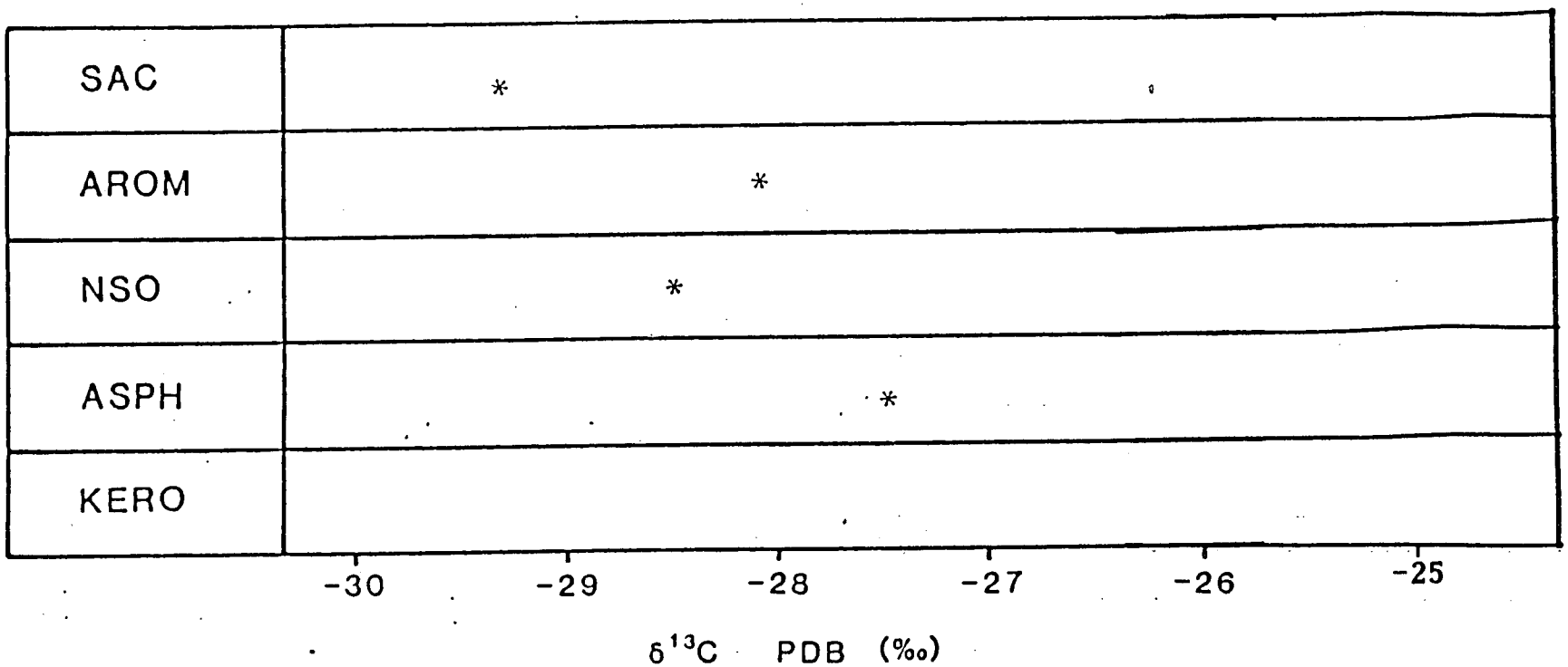


WHOLE OIL $\delta^{13}C$ = -28.59

WHOLE EXTRACT $\delta^{13}C$ =

PYROLYSATE $\delta^{13}C$ =

30/9-2 DST 3



WHOLE OIL $\delta^{13}C$ = -28.53

WHOLE EXTRACT $\delta^{13}C$ =

PYROLYSATE $\delta^{13}C$ =

APPENDIX I

GAS CHROMATOGRAMS - GC-MS FRAGMENTOGRAMS

LIGTH HYDROCARBONS

ALKANE DISTRIBUTION OF THE C_{15+} FRACTION

M/Z 191 TRITERPANES

M/Z 217 STERANES

M/Z 221 D_4-LABLED STERANE STANDARDS

DISTRIBUTION OF AROMATIC HYDROCARBONS, C_{15+} FRACTION

M/Z 231 TRIAROMATIC STERANES

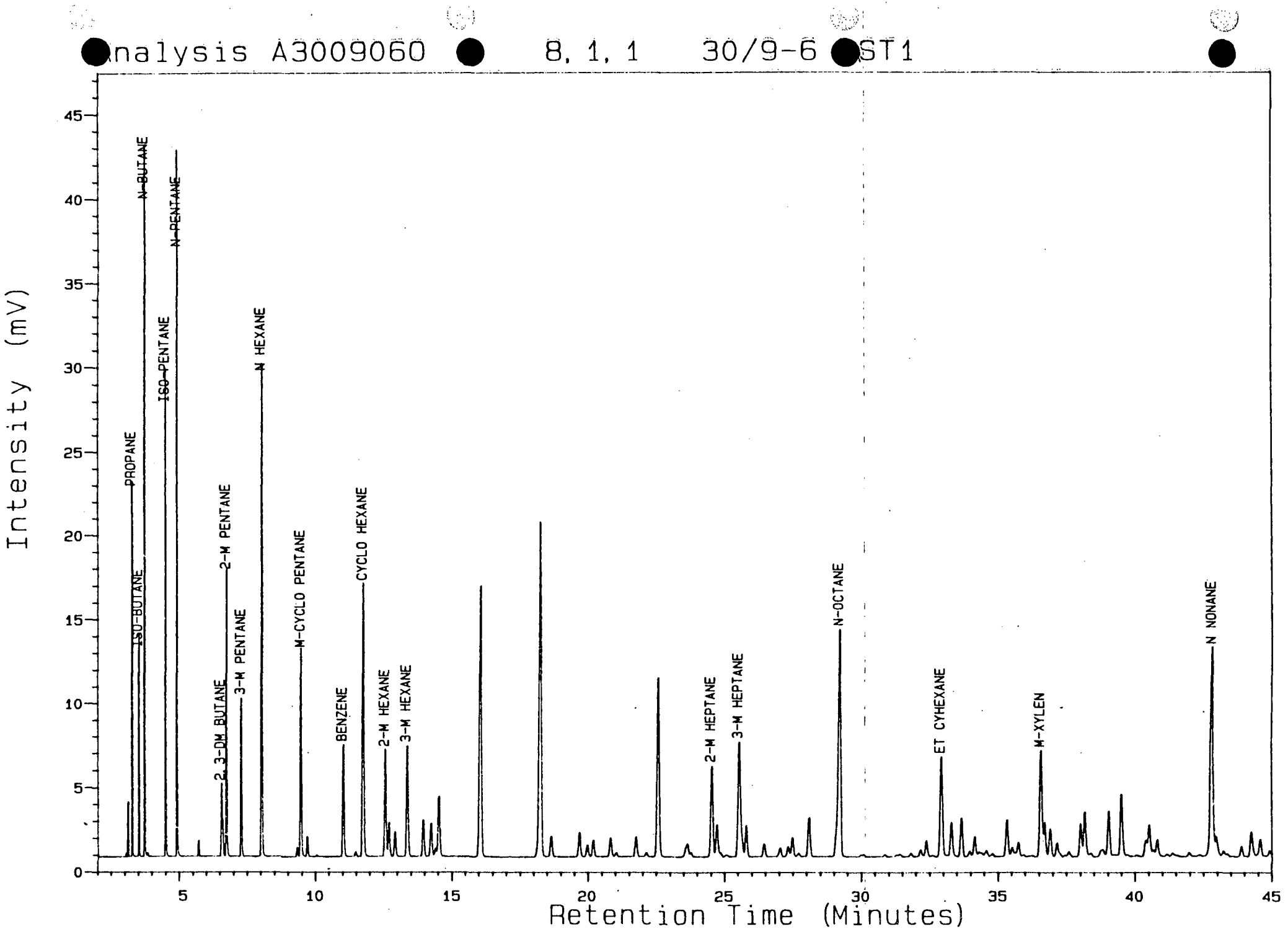
M/Z 233 D_2-LABLED TRIAROMATIC STANDARDS

M/Z 253 MONOAROMATIC STERANES

M/Z 256 D_3-LABLED MONOAROMATIC STANDARDS

CHROMATOGRAMS AND FRAGMENTOGRAMS

WELL 30/9-6, DST 1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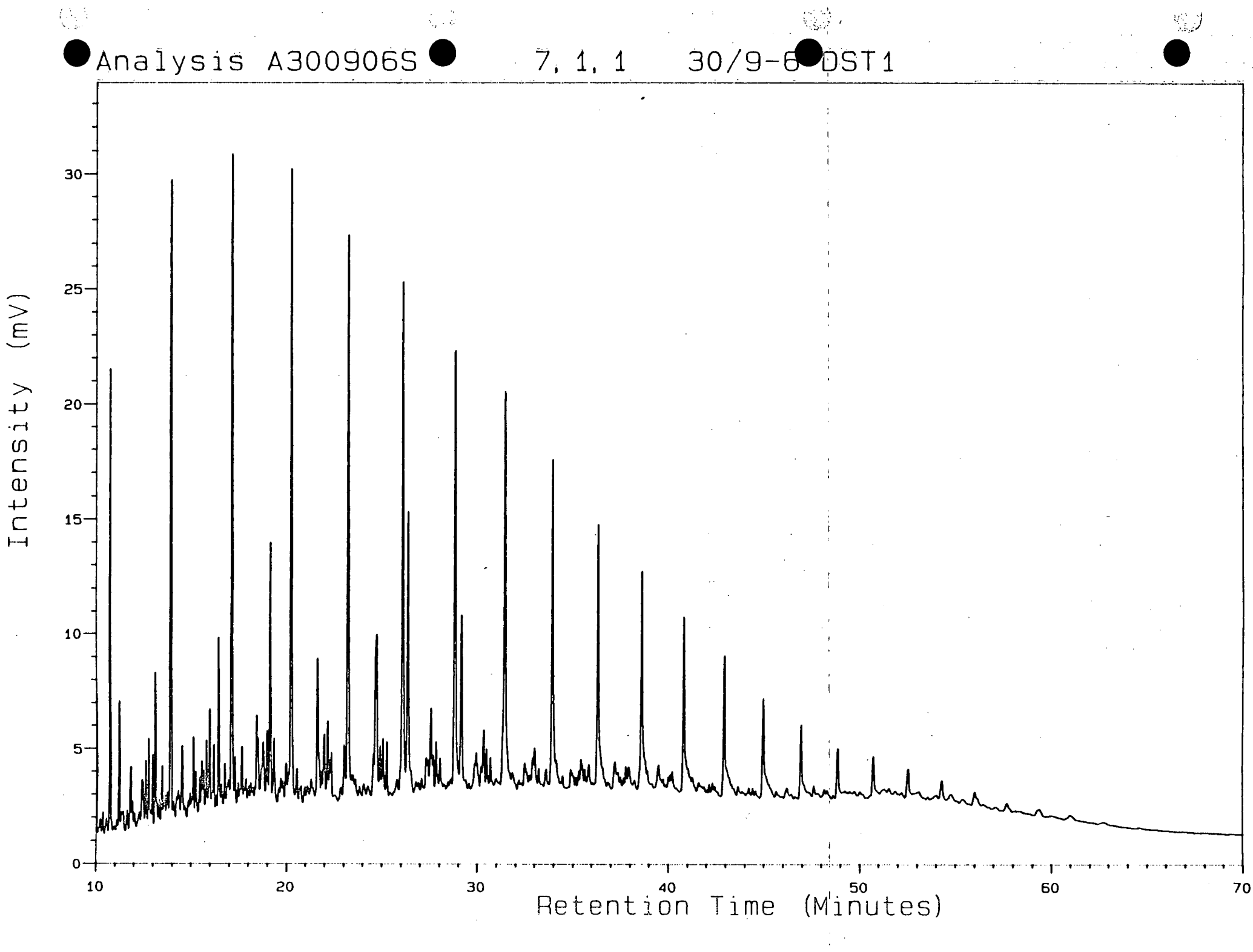
ISO-BUTANE
N-BUTANE
ISO-PENTANE
N-PENTANE
2,3-DM BUTANE
2-M PENTANE
3-M PENTANE
N HEXANE
M-CYCLO PENTANE
BENZENE
CYCLO HEXANE
2-M HEXANE
3-M HEXANE
2-M HEPTANE
3-M HEPTANE
N-OCTANE
ET CYHEXANE
M-XYLEN
N NONANE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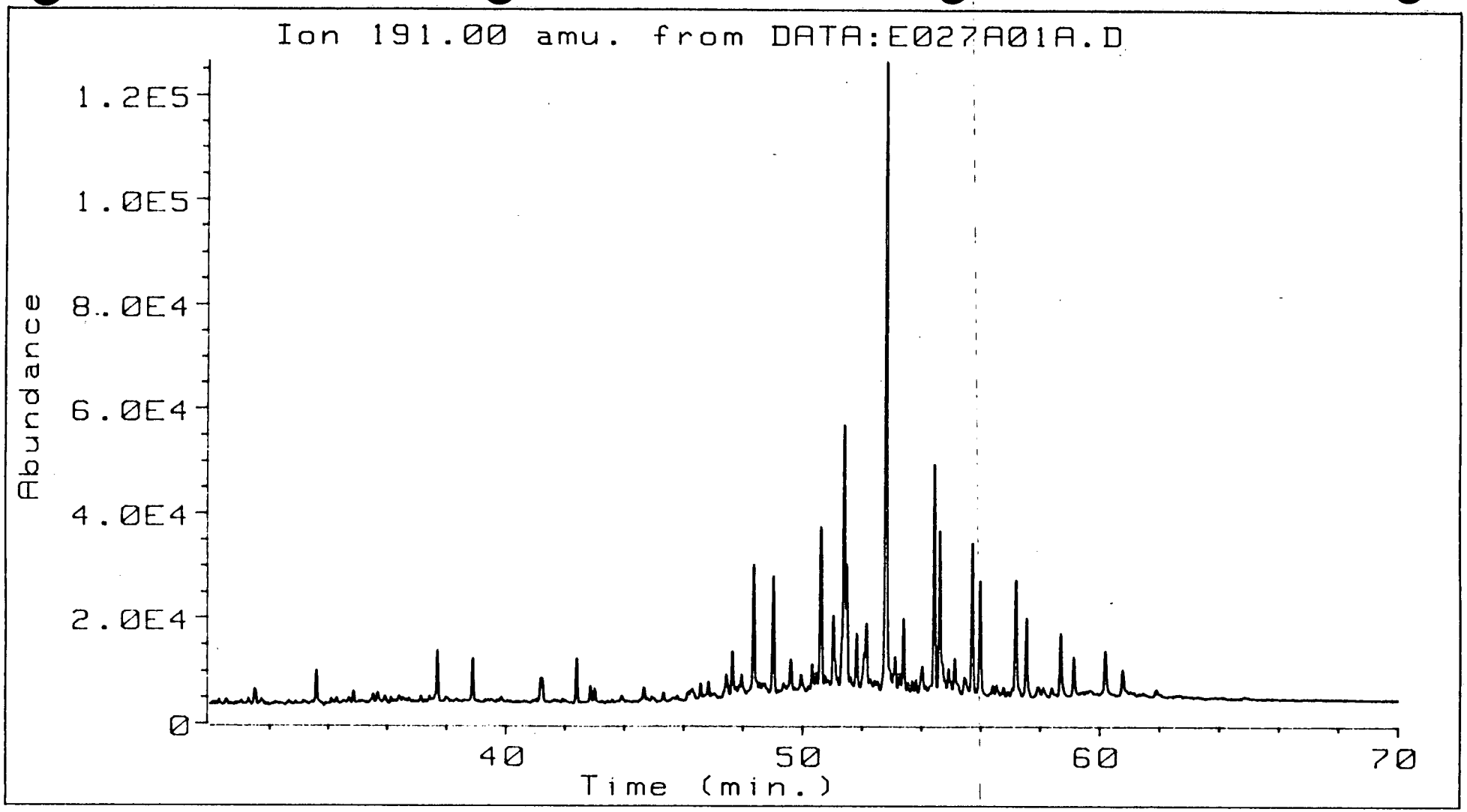
60
70
Retention Time (Minutes)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60
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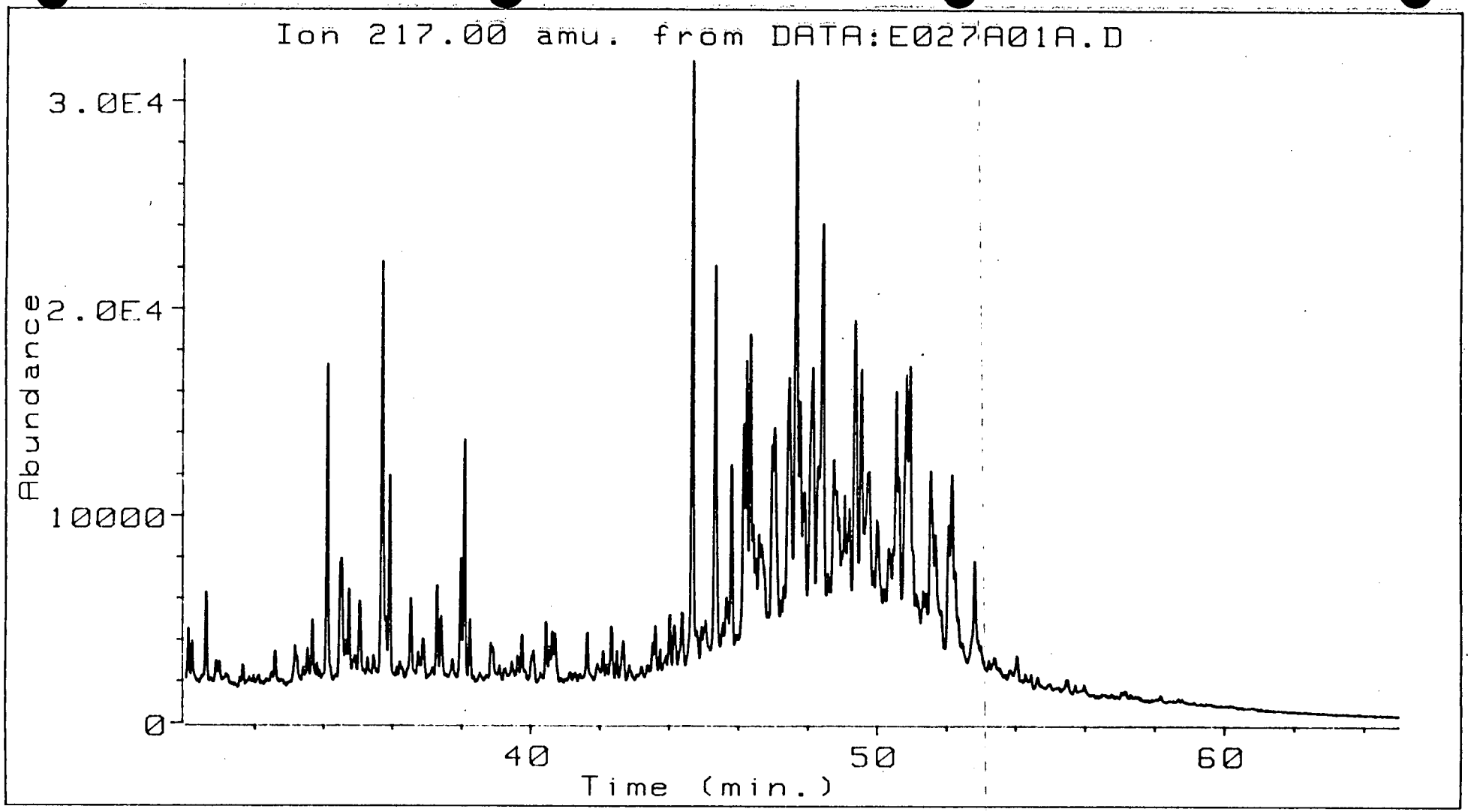
Time (min.)

30/9-6 DST1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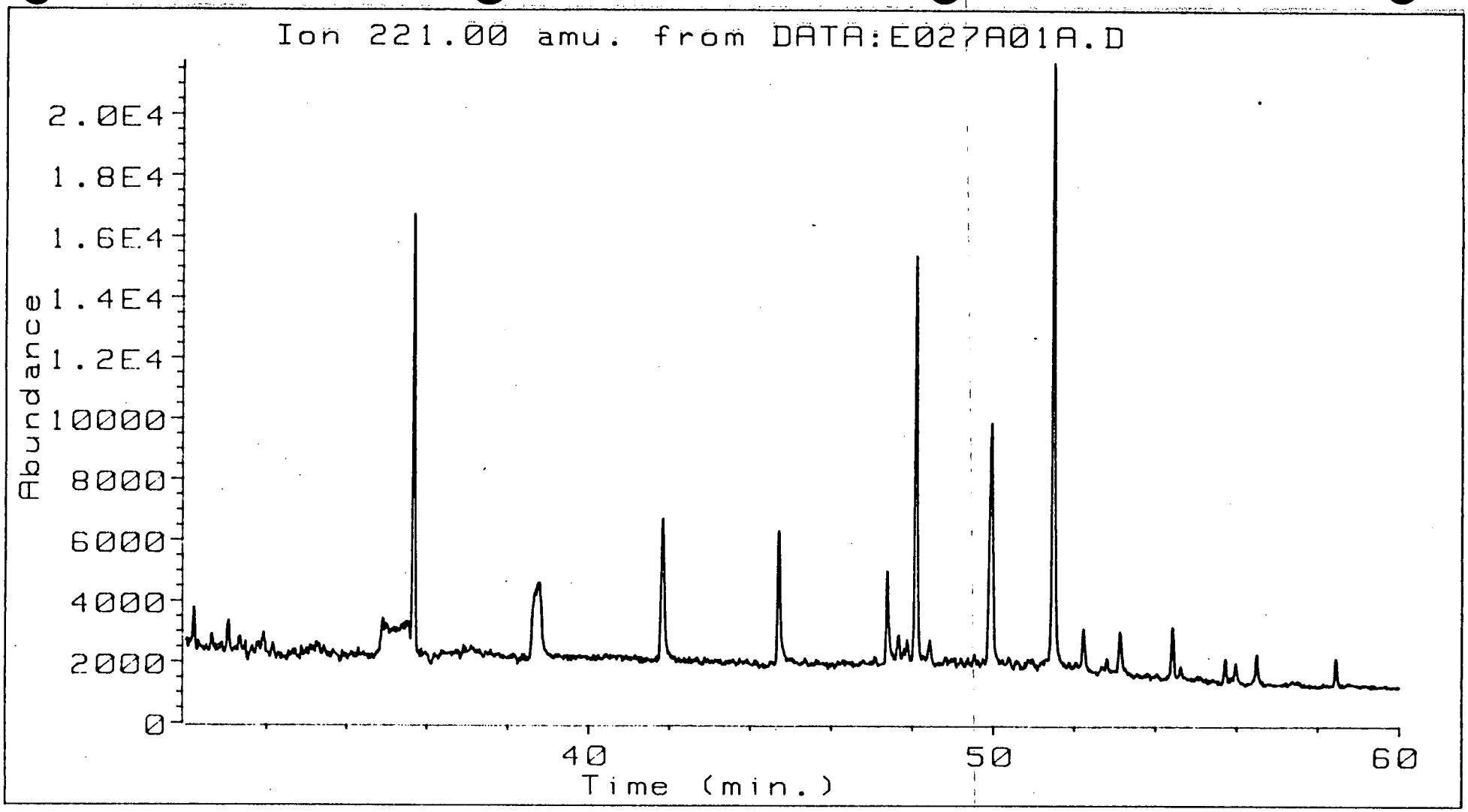
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0
40
50
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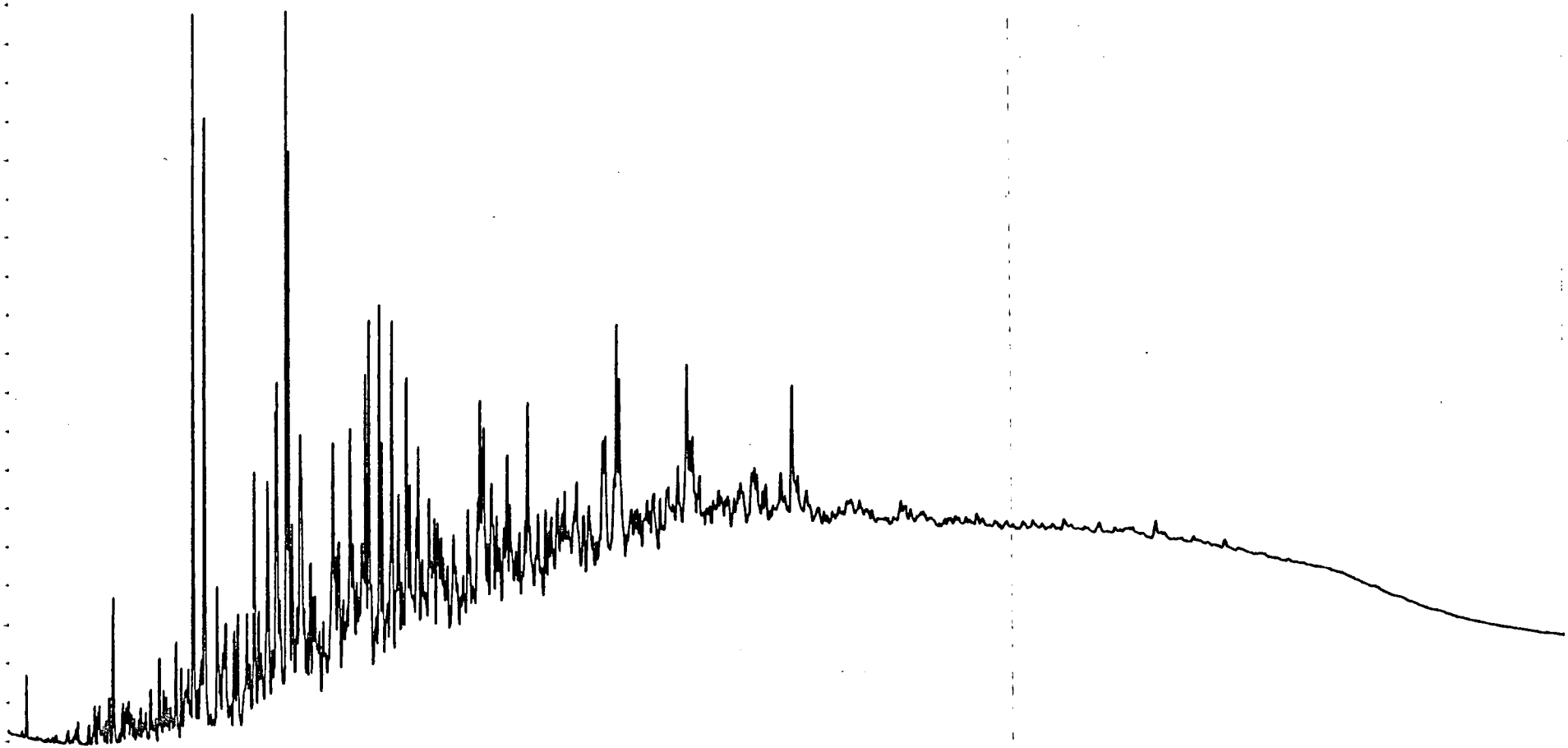
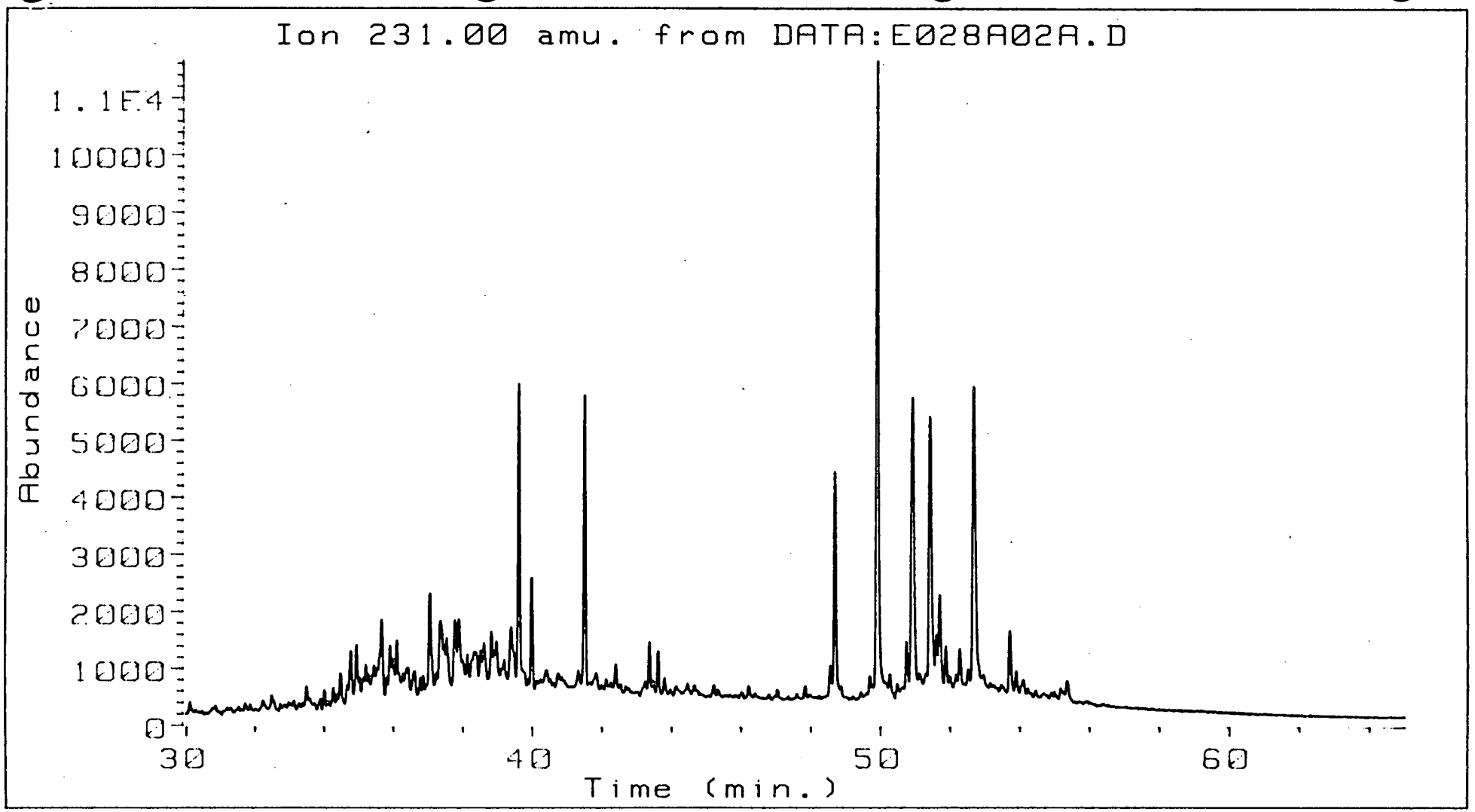
Time (min.)

30/9-6 DST1

Analysis A300906A 7, 2, 1 30/9-6 DST 1

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50
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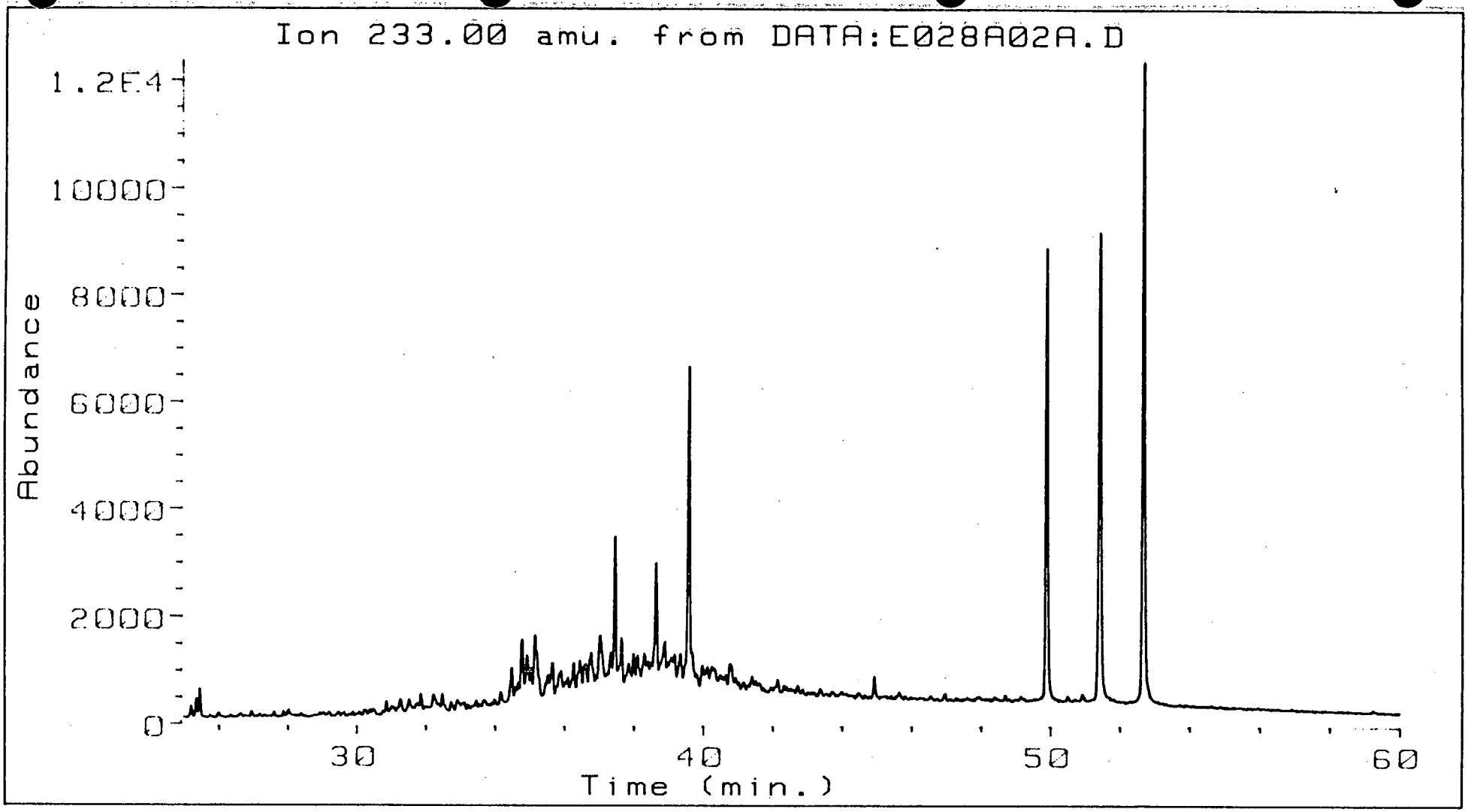
Time (min.)

30/9-6 DST1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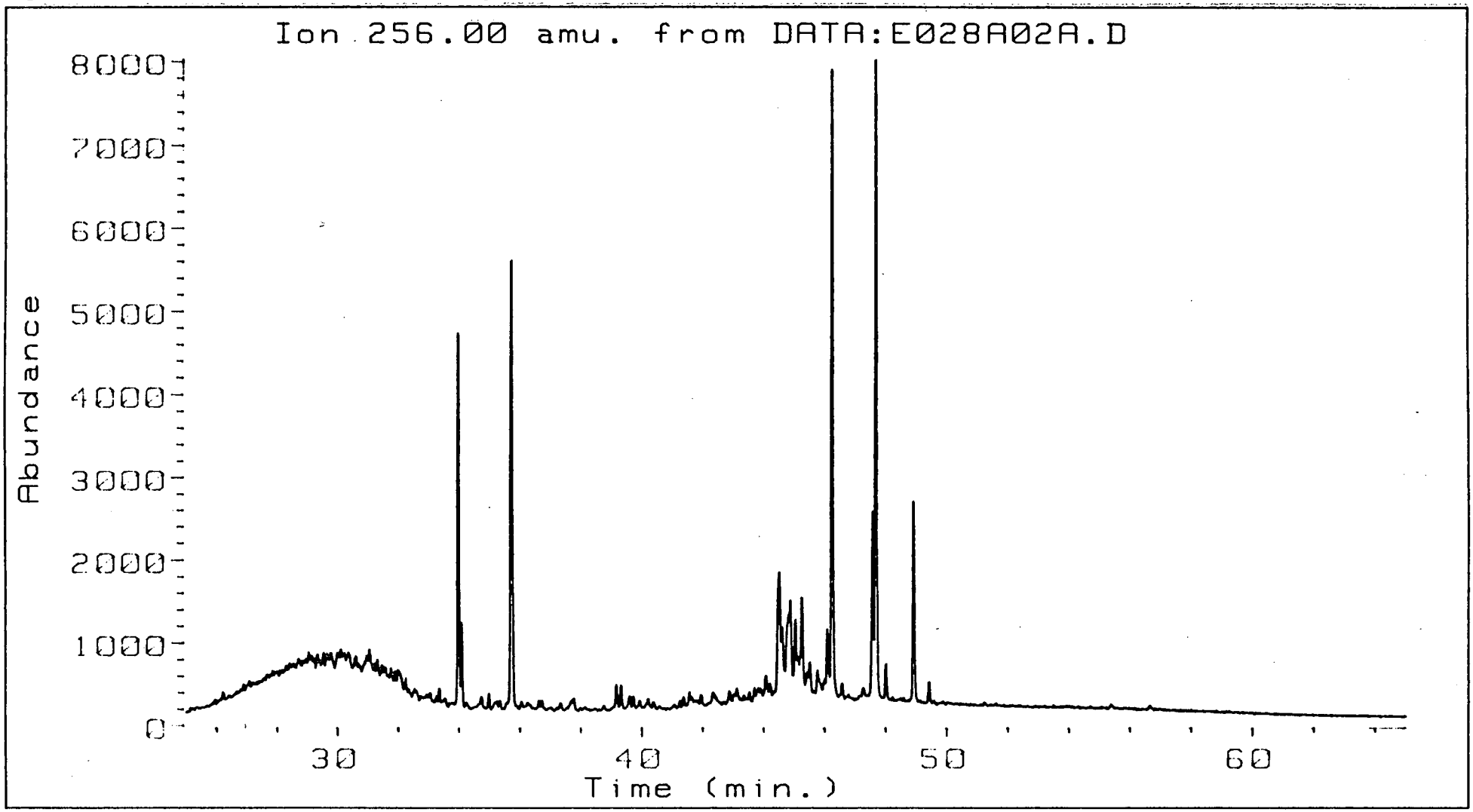
30/9-6 DST1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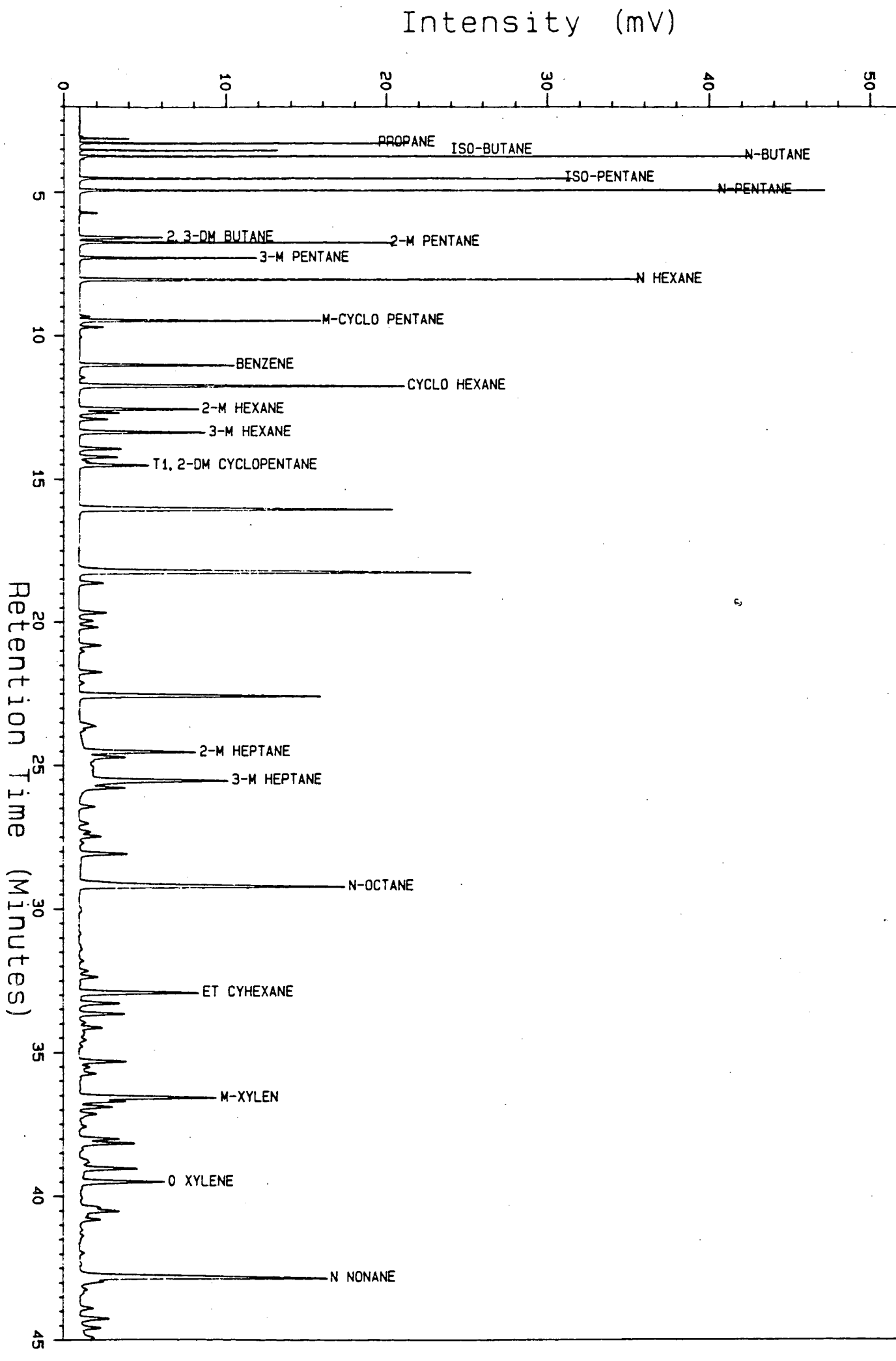
Time (min.)

30/9-6 DST1

CHROMATOGRAMS AND FRAGMENTOGRAMS

WELL 30/9-6, DST 2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N-BUTANE
ISO-PENTANE
N-PENTANE
2,3-DM BUTANE
2-M PENTANE
3-M PENTANE
N HEXANE
M-CYCLO PENTANE
BENZENE
CYCLO HEXANE
2-M HEXANE
3-M HEXANE
T1, 2-DM CYCLOPENTANE
2-M HEPTANE
3-M HEPTANE
N-OCTANE
ET CYHEXANE
M-XYLEN
O XYLENE
N NONANE
Retention Time (Minutes)
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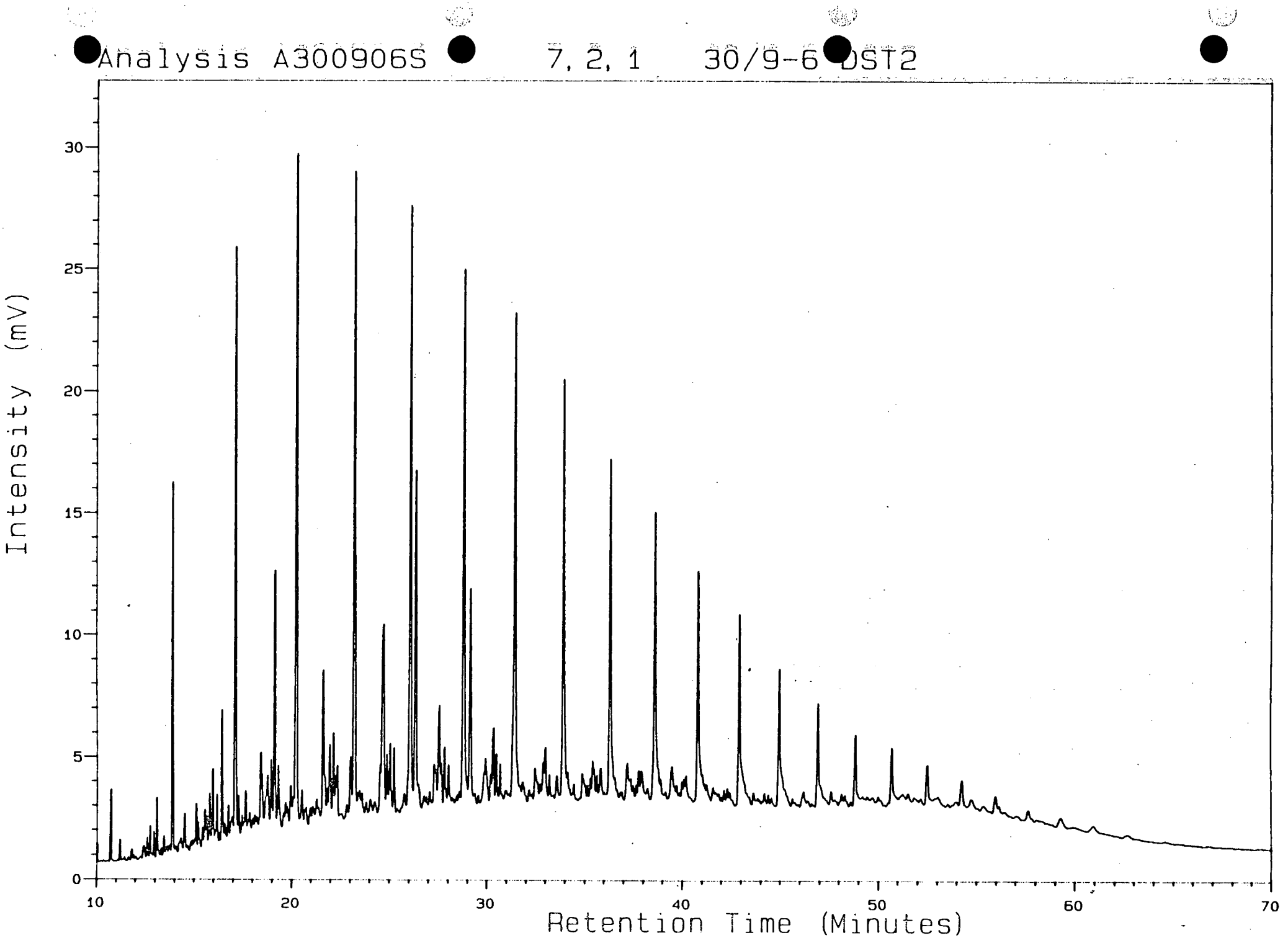
10
15
20
25
30
35
40
45
Analysis A3009060 8,2,1 30/9-6 ST2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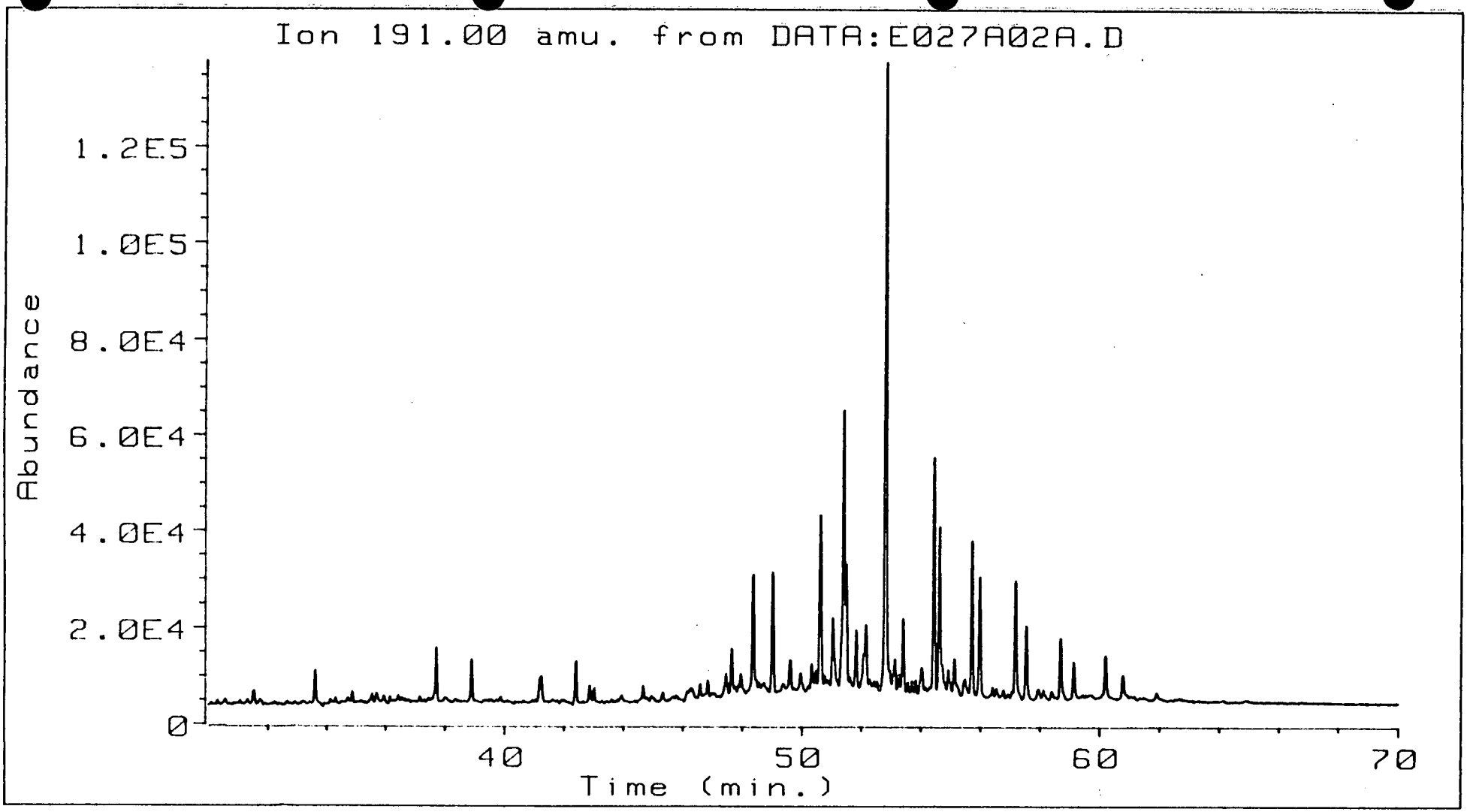
Retention Time (Minutes)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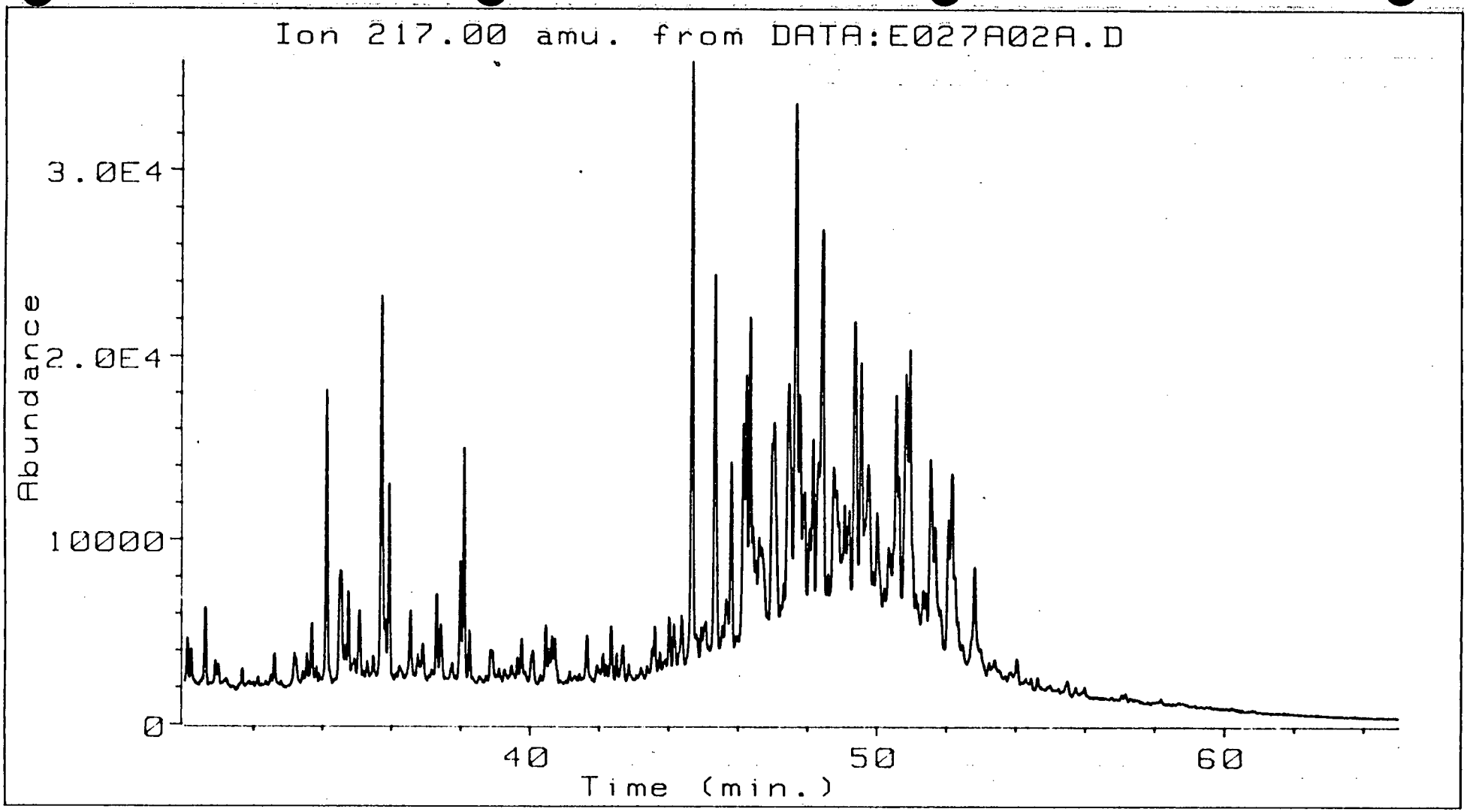
Time (min.)

30/9-6 DST2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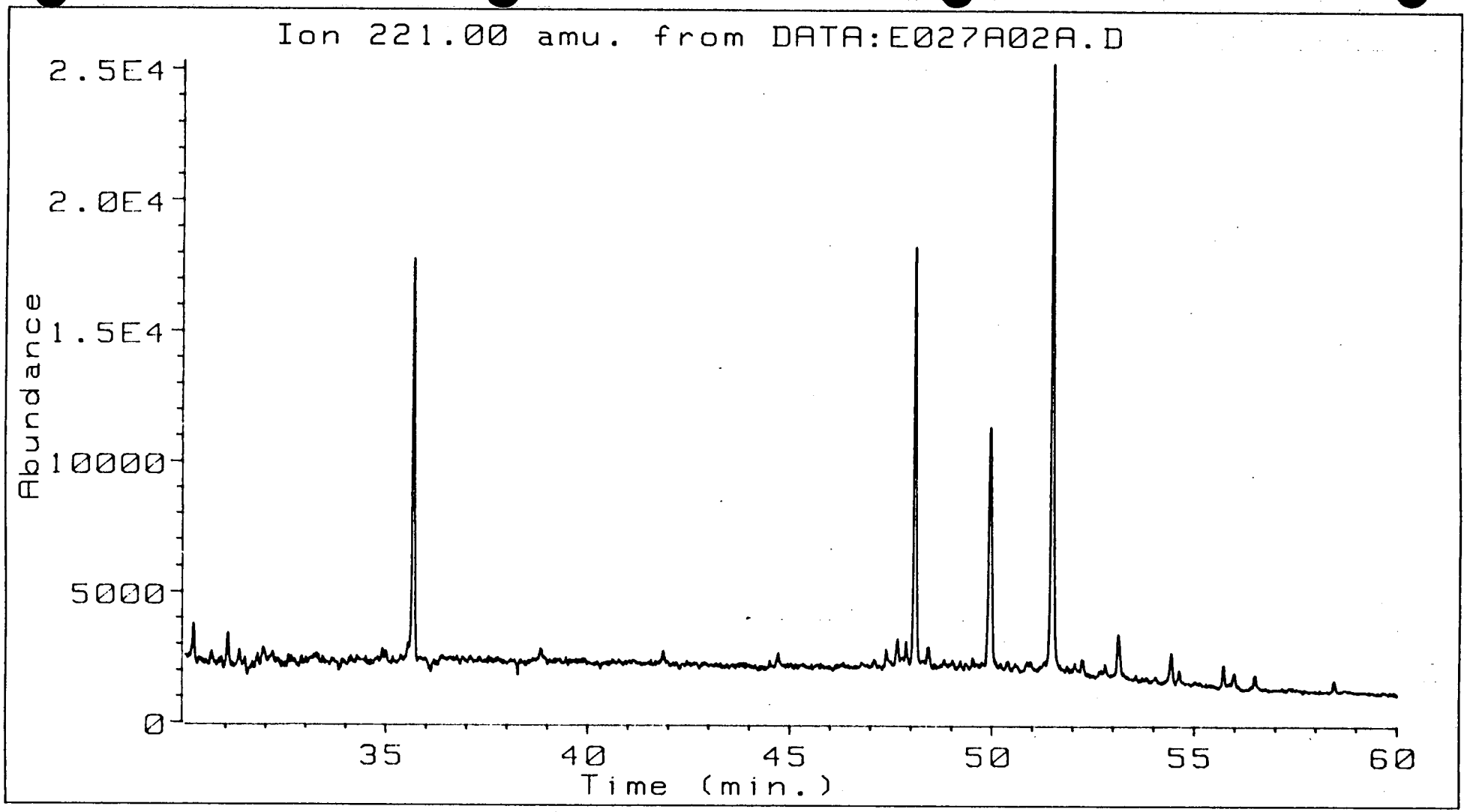
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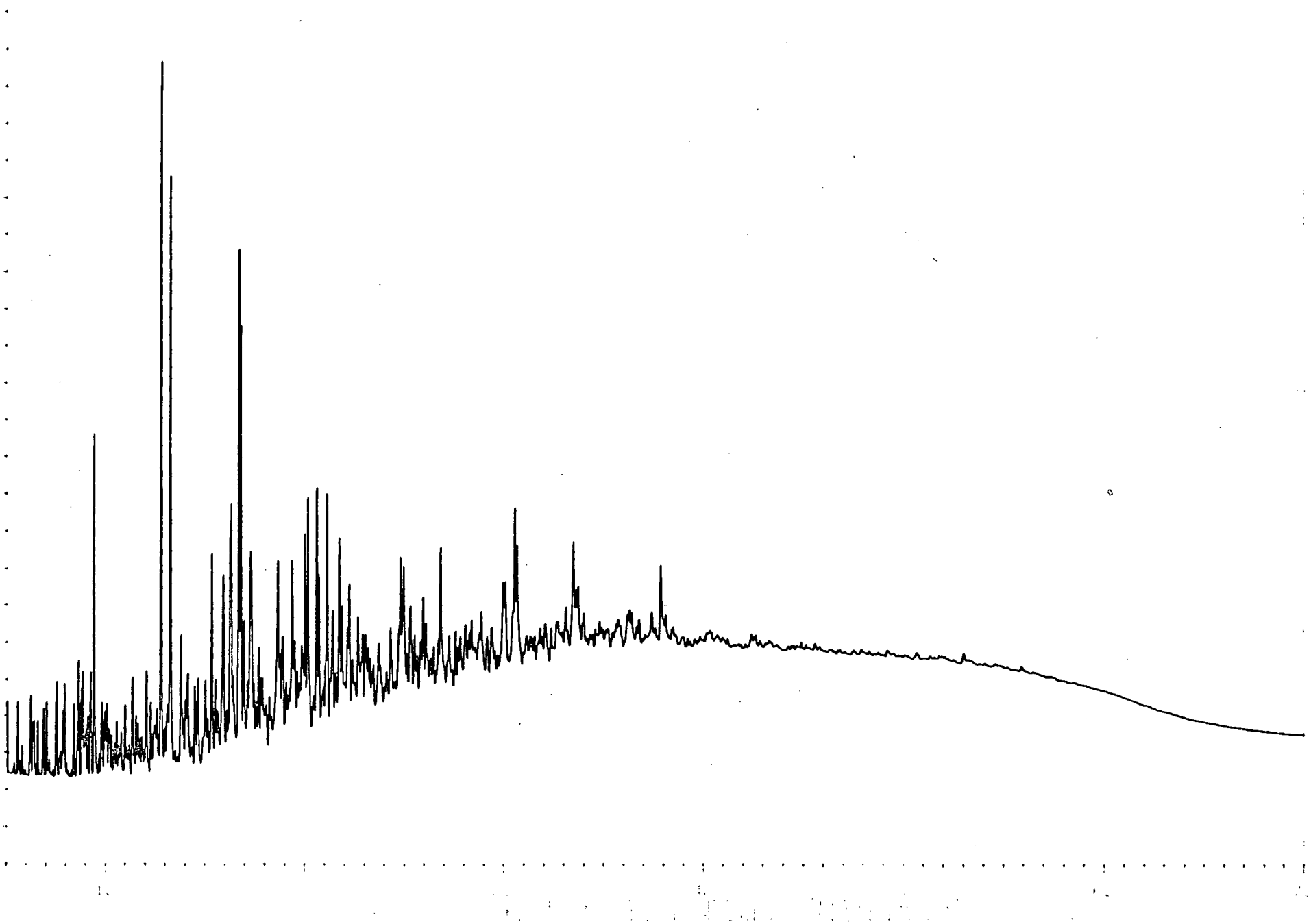
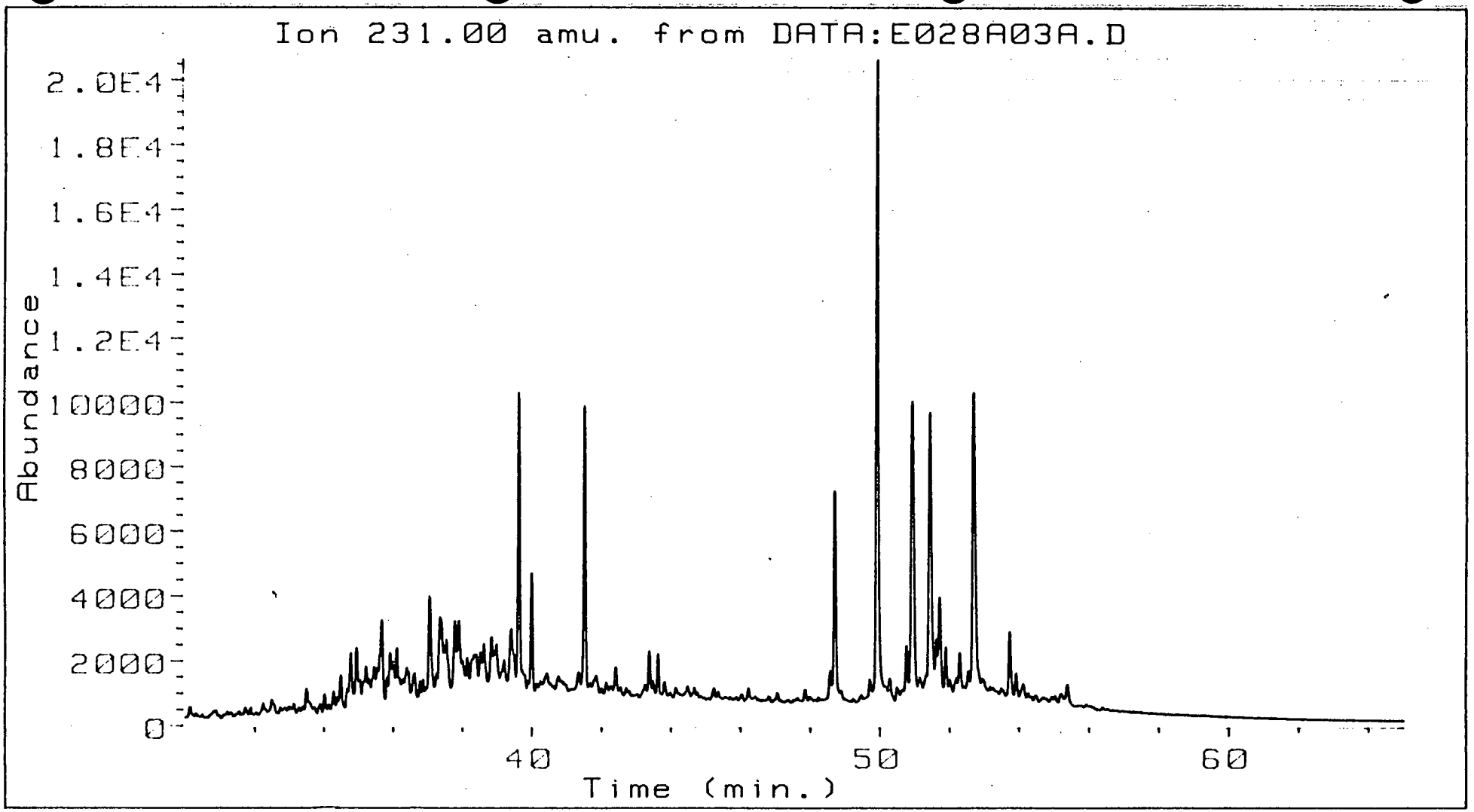
Time (min.)

30/9-6 DST2

Analysis A300906A 7, 3, 1 30/9-6 DST 2

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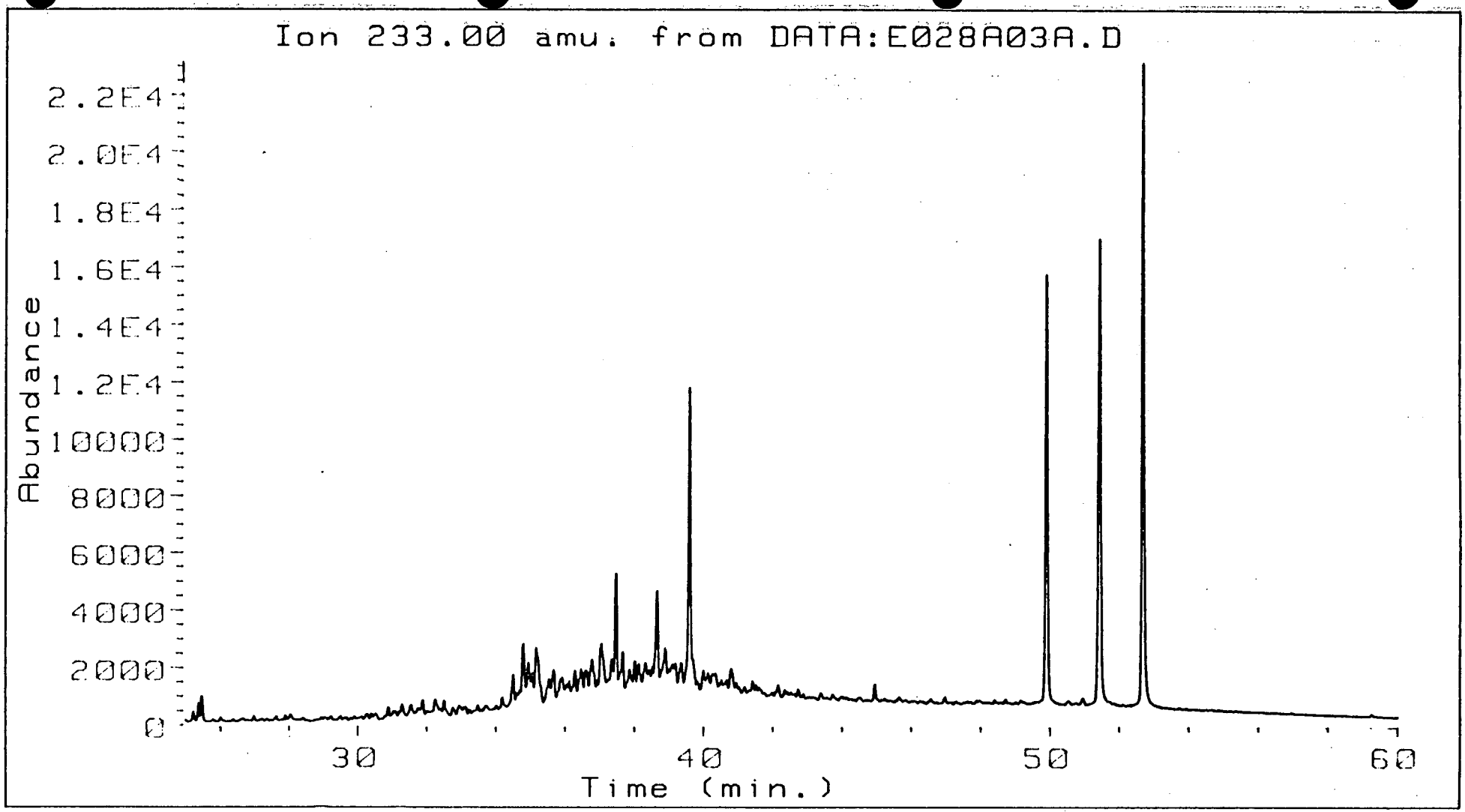
40
50
60
Time (min.)

30/9-6 DST2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4000
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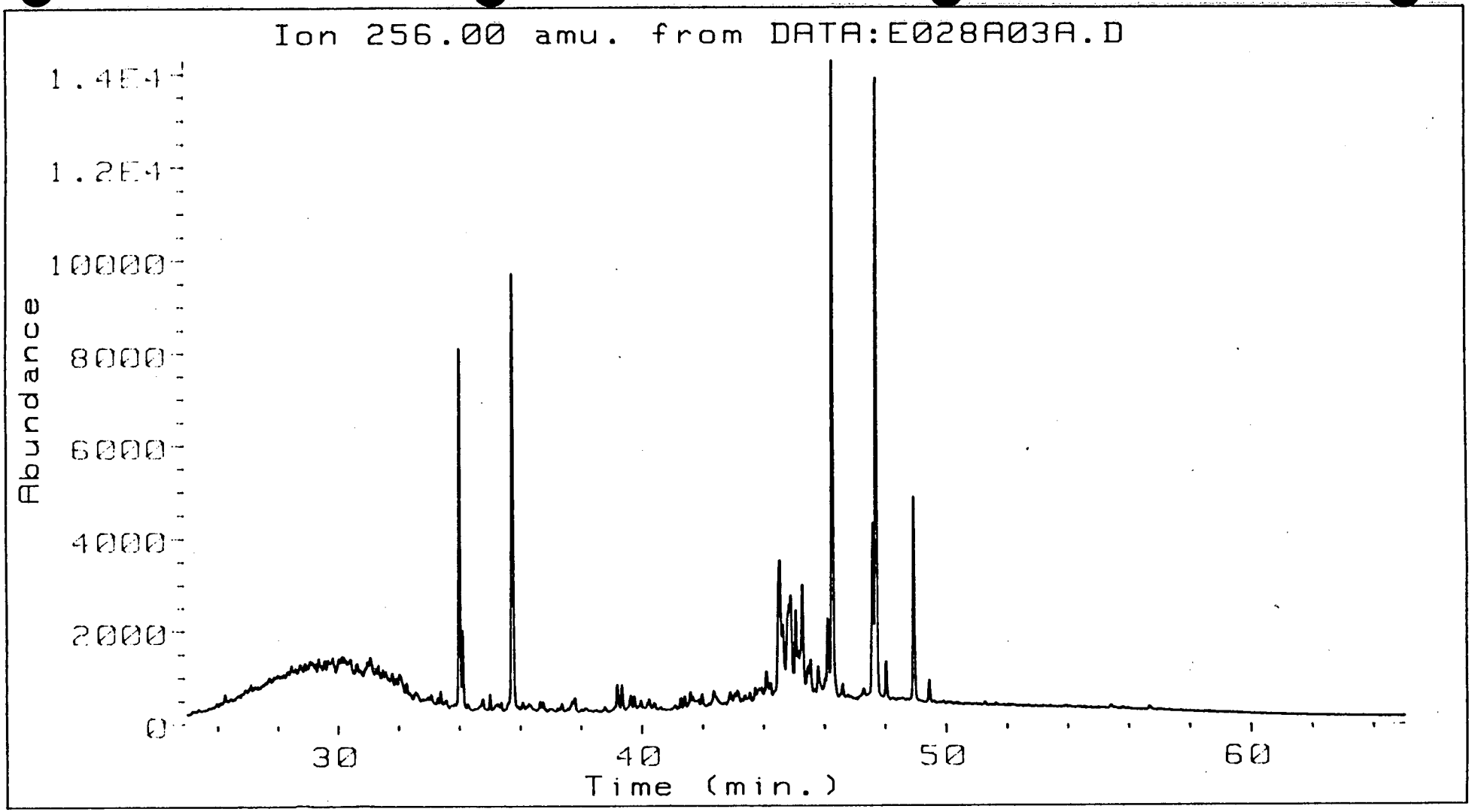
0
30
40
50
60
Time (min.)

30/9-6 DST2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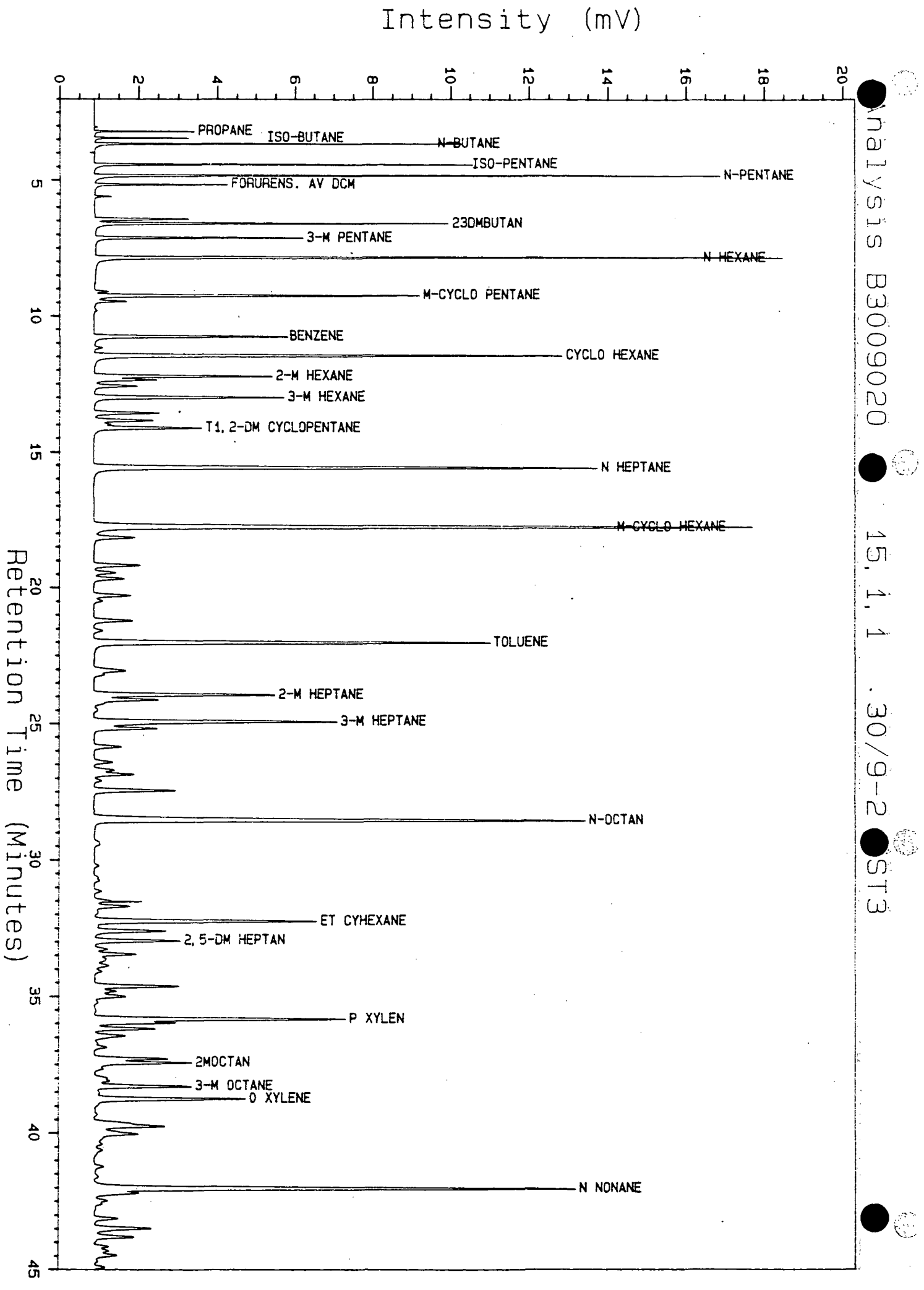
Time (min.)

30/9-6 DST2

CHROMATOGRAMS AND FRAGMENTOGRAMS

WELL 30/9-2 DST 3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N-PENTANE
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N HEXANE
M-CYCLO PENTANE
BENZENE
CYCLO HEXANE
2-M HEXANE
3-M HEXANE
T1, 2-DM CYCLOPENTANE
N HEPTANE
M-CYCLO HEXANE
TOLUENE
2-M HEPTANE
3-M HEPTANE
N-OCTAN
ET CYHEXANE
2, 5-DM HEPTAN
P XYLEN
2MOCTAN
3-M OCTANE
O XYLENE
N NONANE
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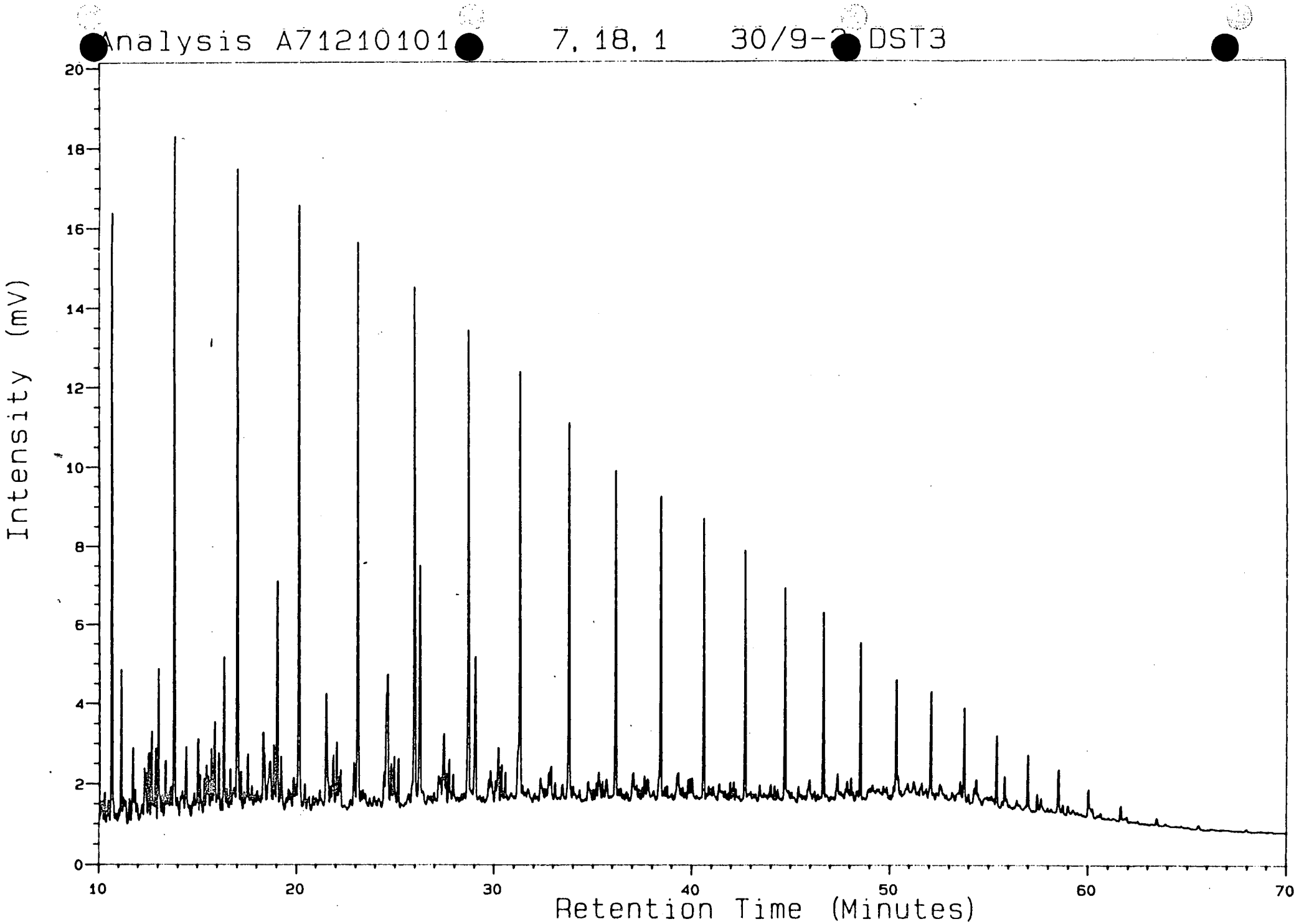
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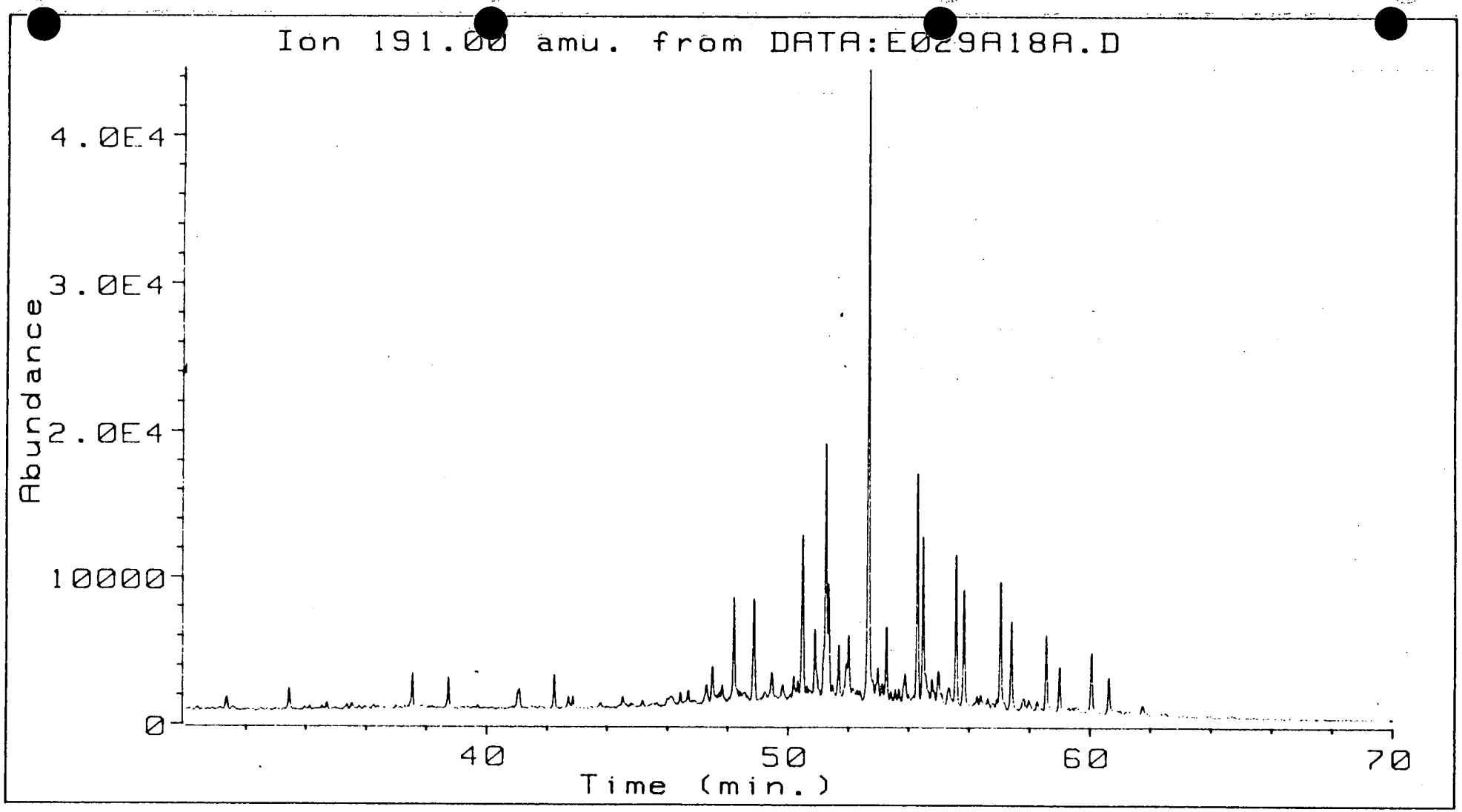
Retention Time (Minutes)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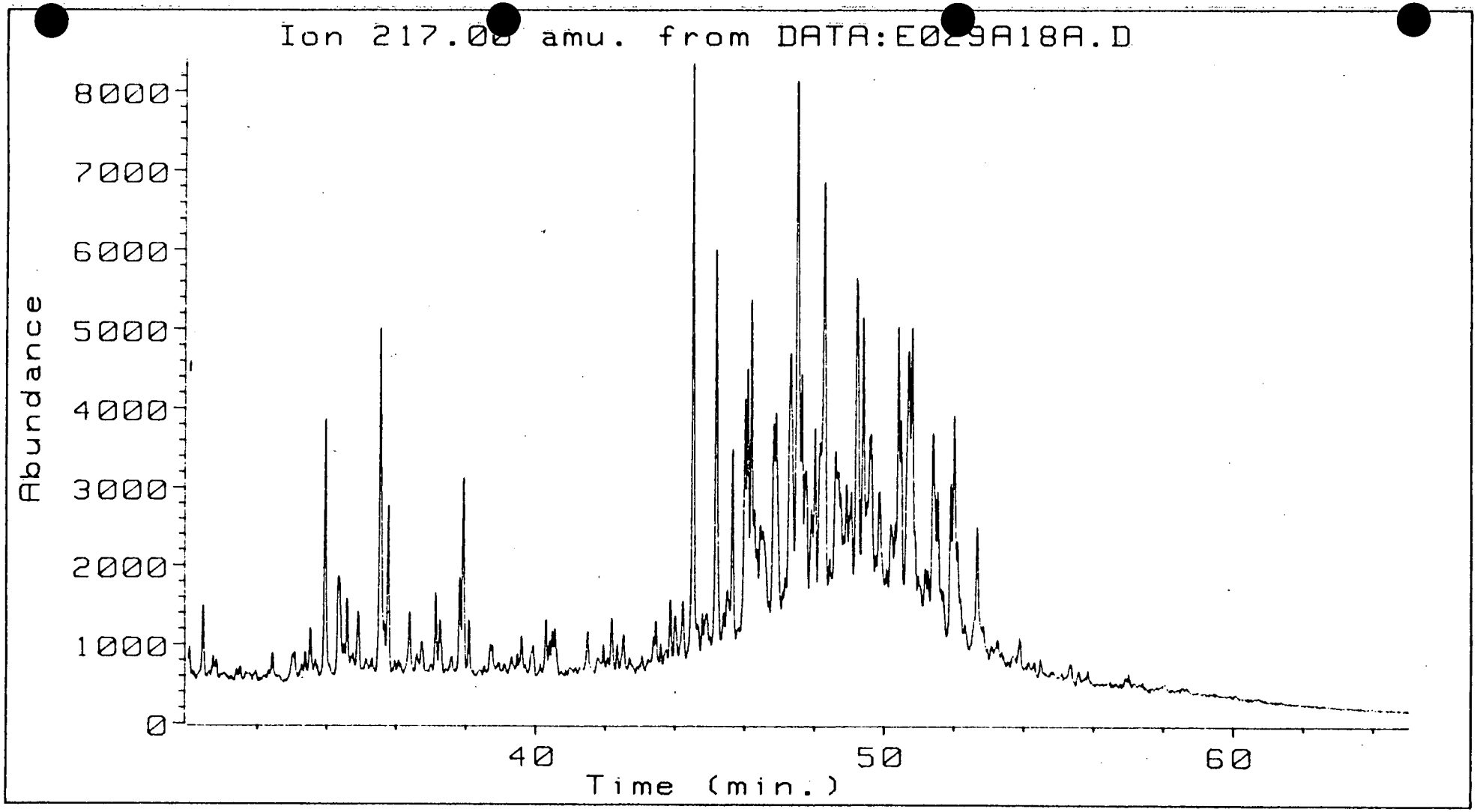
Time (min.)

30/9-2 DST3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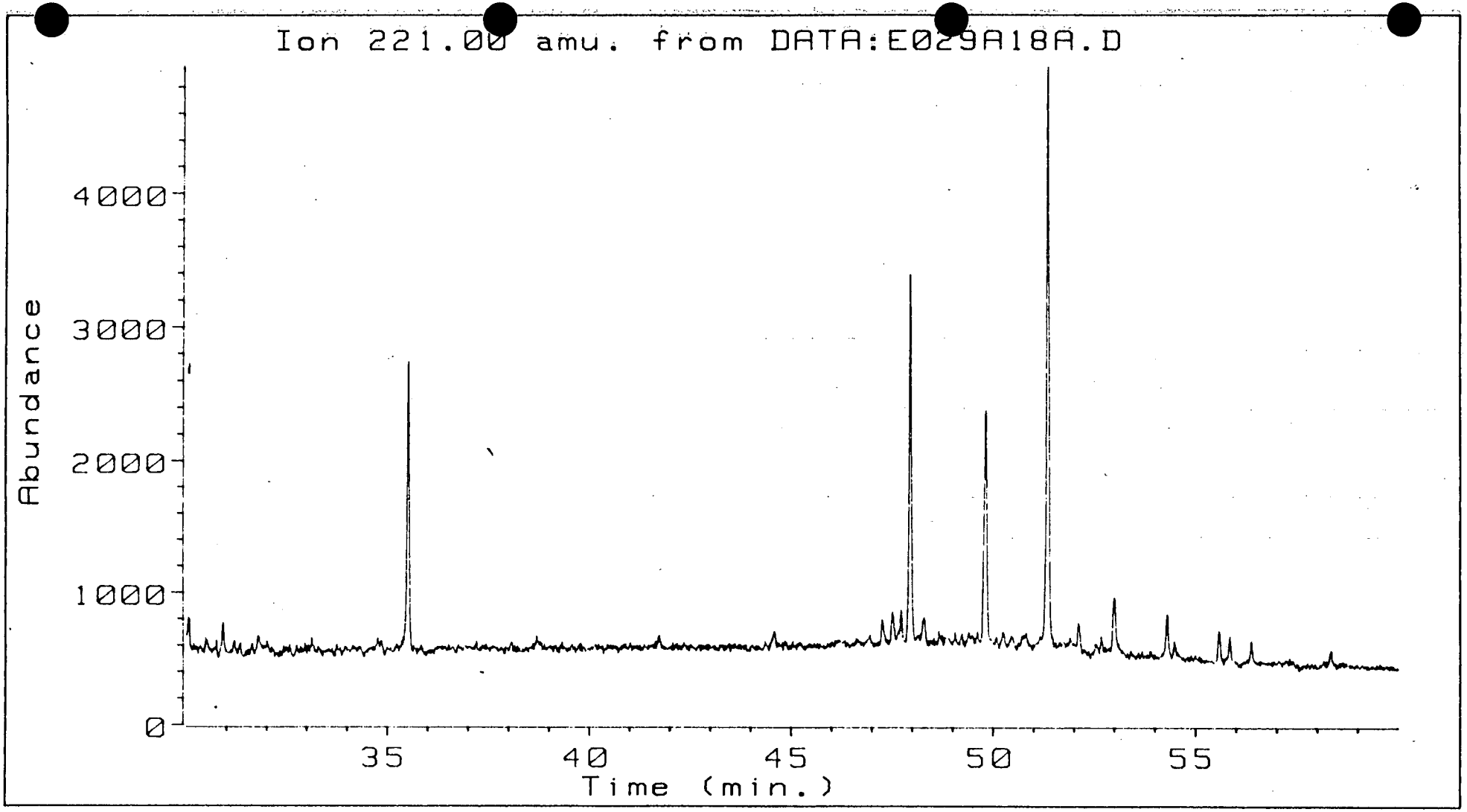
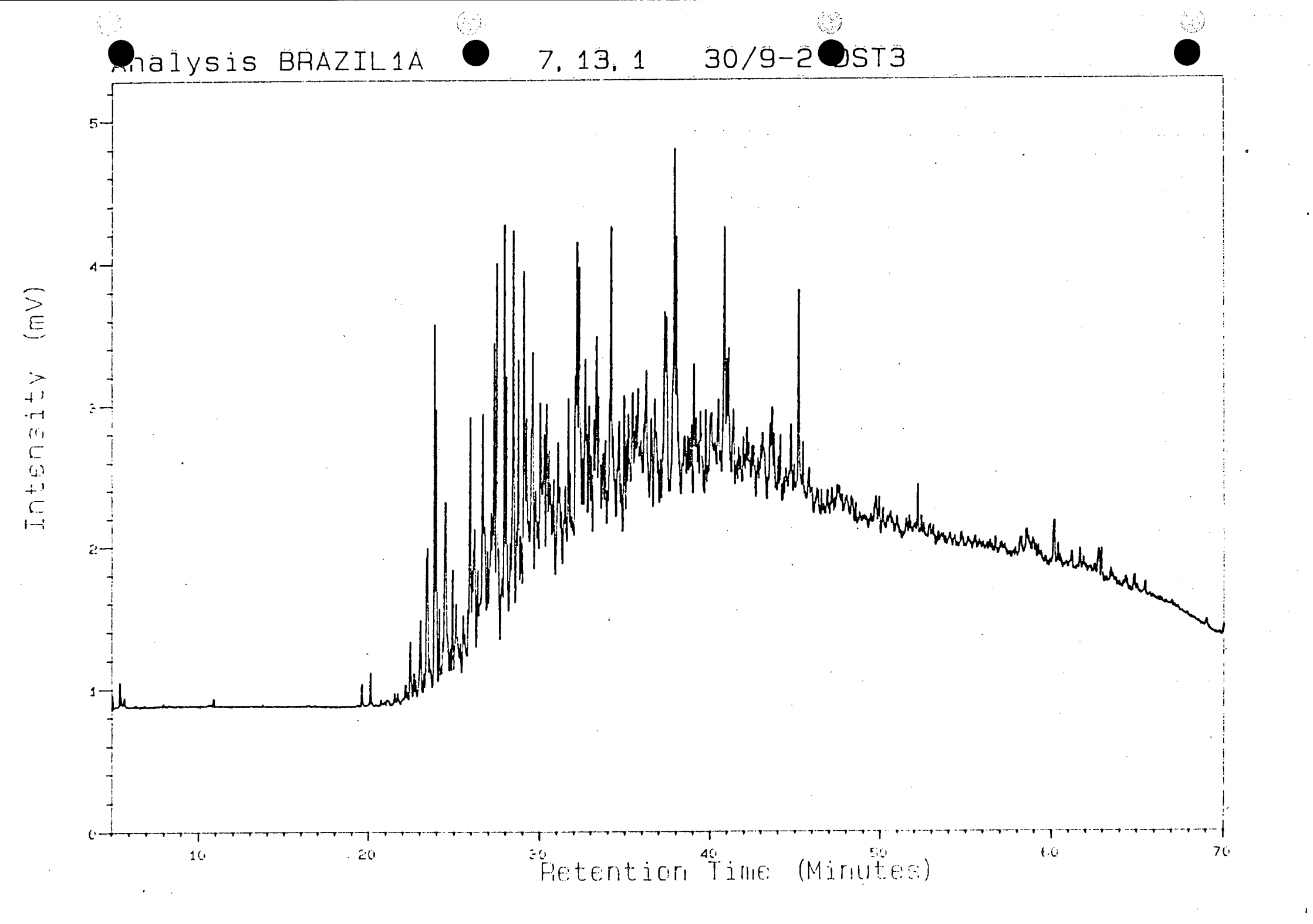
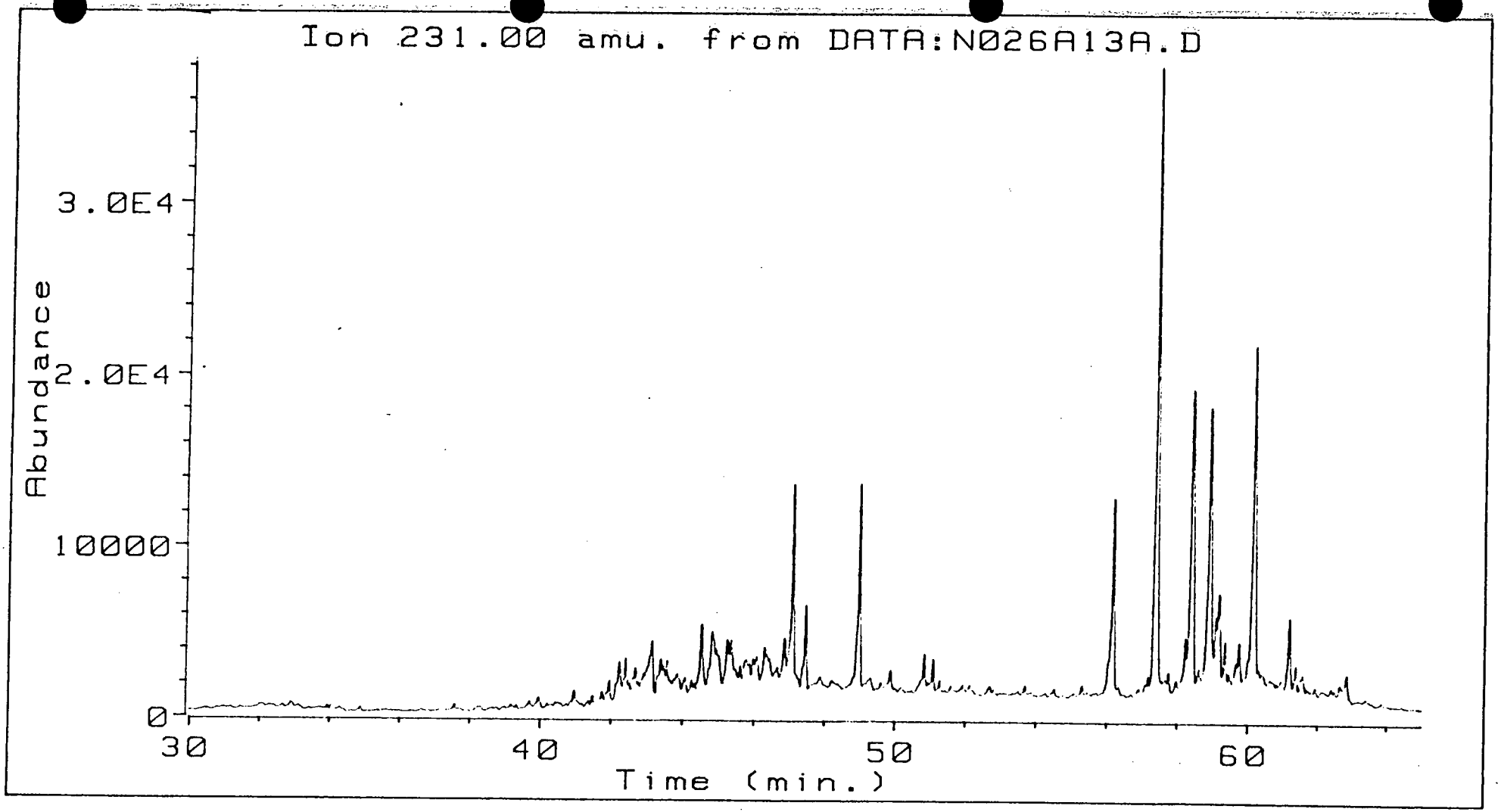
Time (min.)

30/9-2 DST3

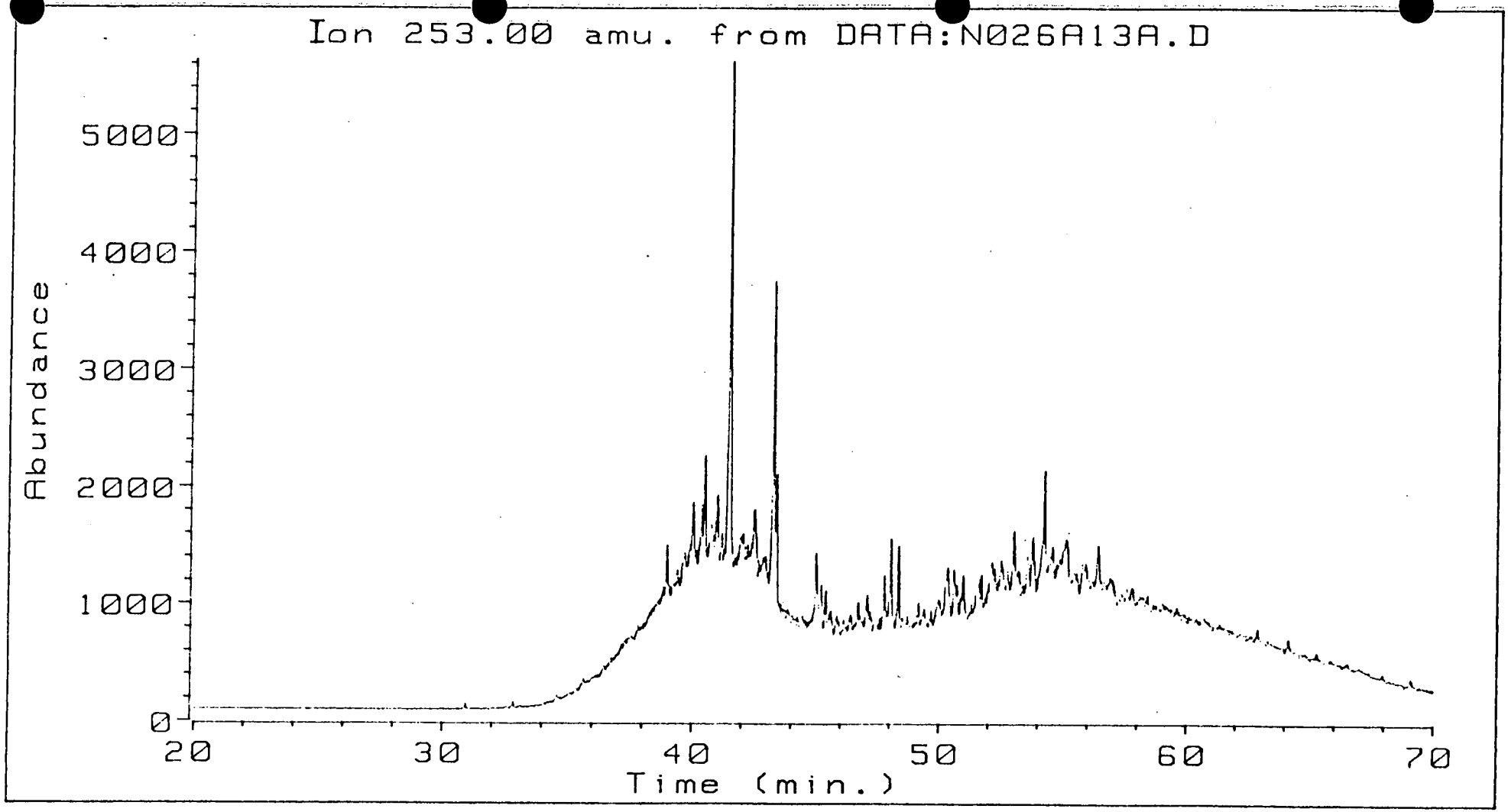

Ion 221.00 amu. from DATA:E029A18A.D
Abundance
4000
3000
2000
1000
0
35
40
45
50
55
Time (min.)

30/9-2 DST3


Analysis BRAZIL1A 7, 13, 1 30/9-2 DST3
Intensity (mV)
0
1
2
3
4
5
10
20
30
40
50
60
70
Retention Time (Minutes)


Ion 231.00 amu. from DATA:N026A13A.D
3.0E4
2.0E4
10000
0
Abundance
30
40
50
60
Time (min.)

30/9-2 DST3


Ion 253.00 amu. from DATA:N026A13A.D
Abundance
5000
4000
3000
2000
1000
0
20
30
40
50
60
70
Time (min.)

30/9-2 DST3

APPENDIX II

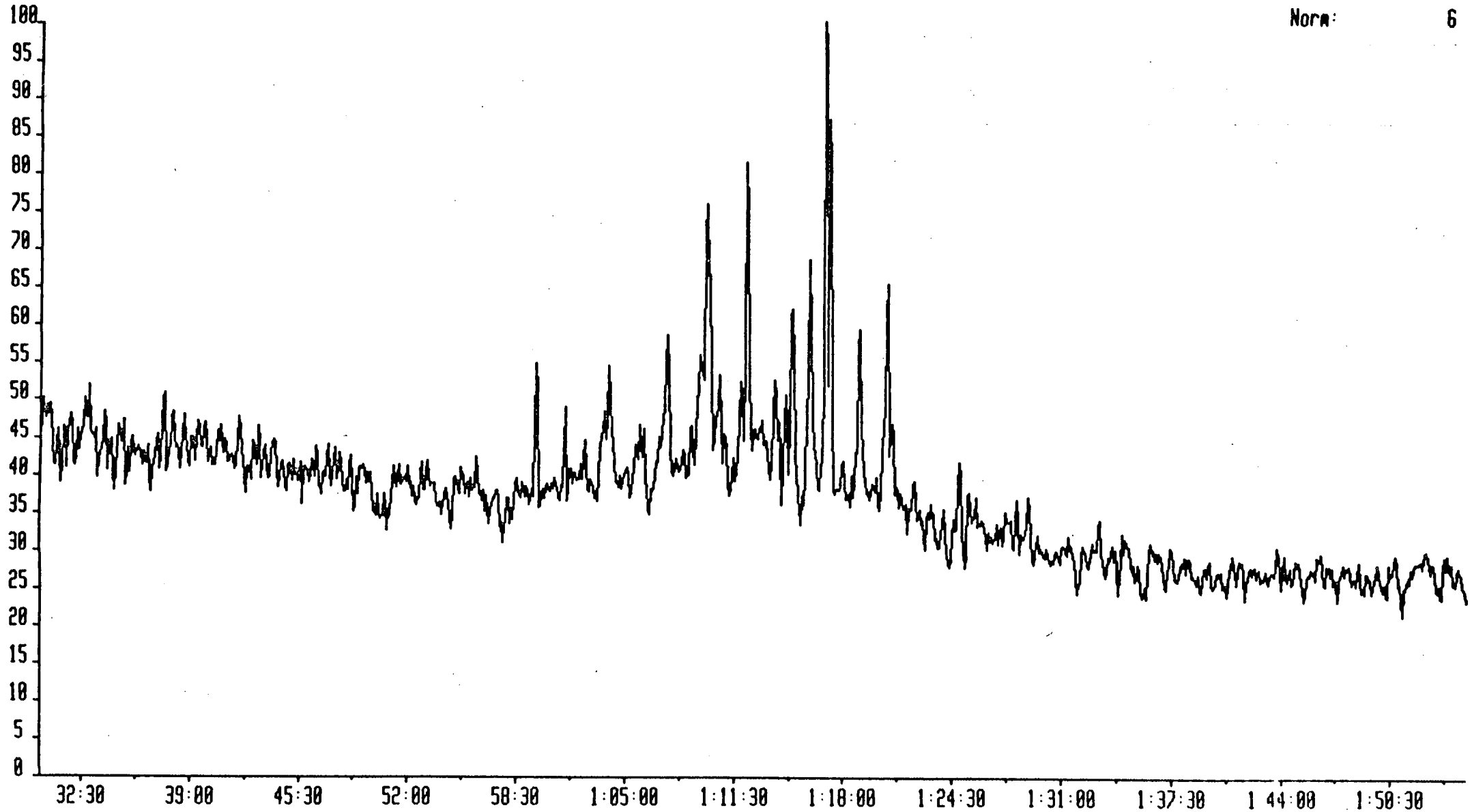
FRAGMENTOGRAMS FROM HIGH RESOLUTION GC-MS ANALYSIS

M/Z 177	DEMETHYLIZED TRITERPANES
M/Z 191	TRITERPANES
M/Z 197	N-ALKANES
M/Z 205	METHYLIZED TRITERPANES
M/Z 217	STERANES
M/Z 218	STERANES
M/Z 221	D_4-STERANES STANDARDS
M/Z 231.1	TRIAROMATIC STERANES
M/Z 231.2	C_{30}-STERANES
M/Z 233.1	D_3-TRIAROMATIC STERANES
M/Z 245	TRIAROMATIC STERANES
M/Z 253	MONOAROMATIC STERANES
M/Z 256	D_3-MONOAROMATIC STERANES
M/Z 259	DIASTERANES

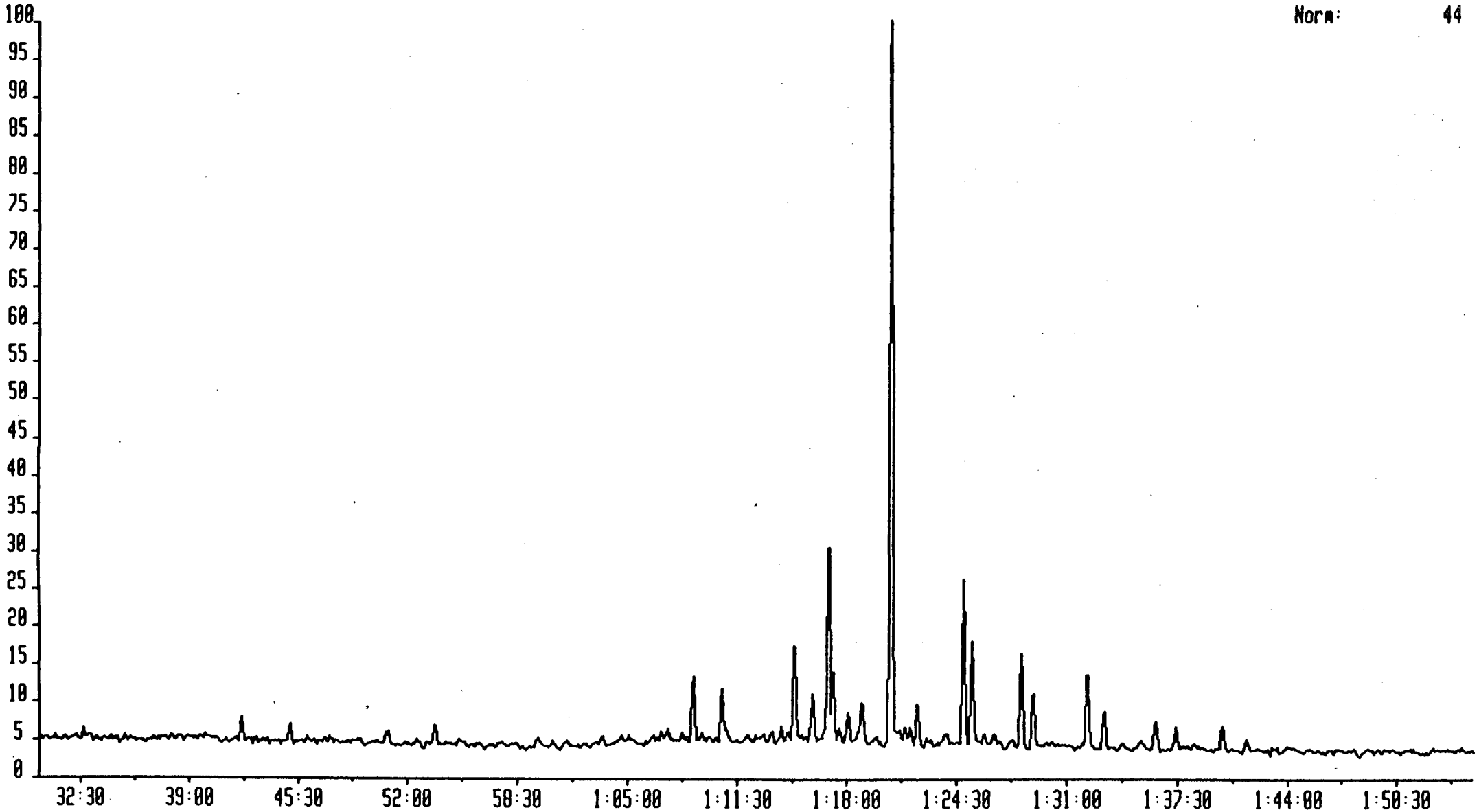
HIGH RESOLUTION MASS FRAGMENTOGRAMS

WELL 30/9-6, DST 1

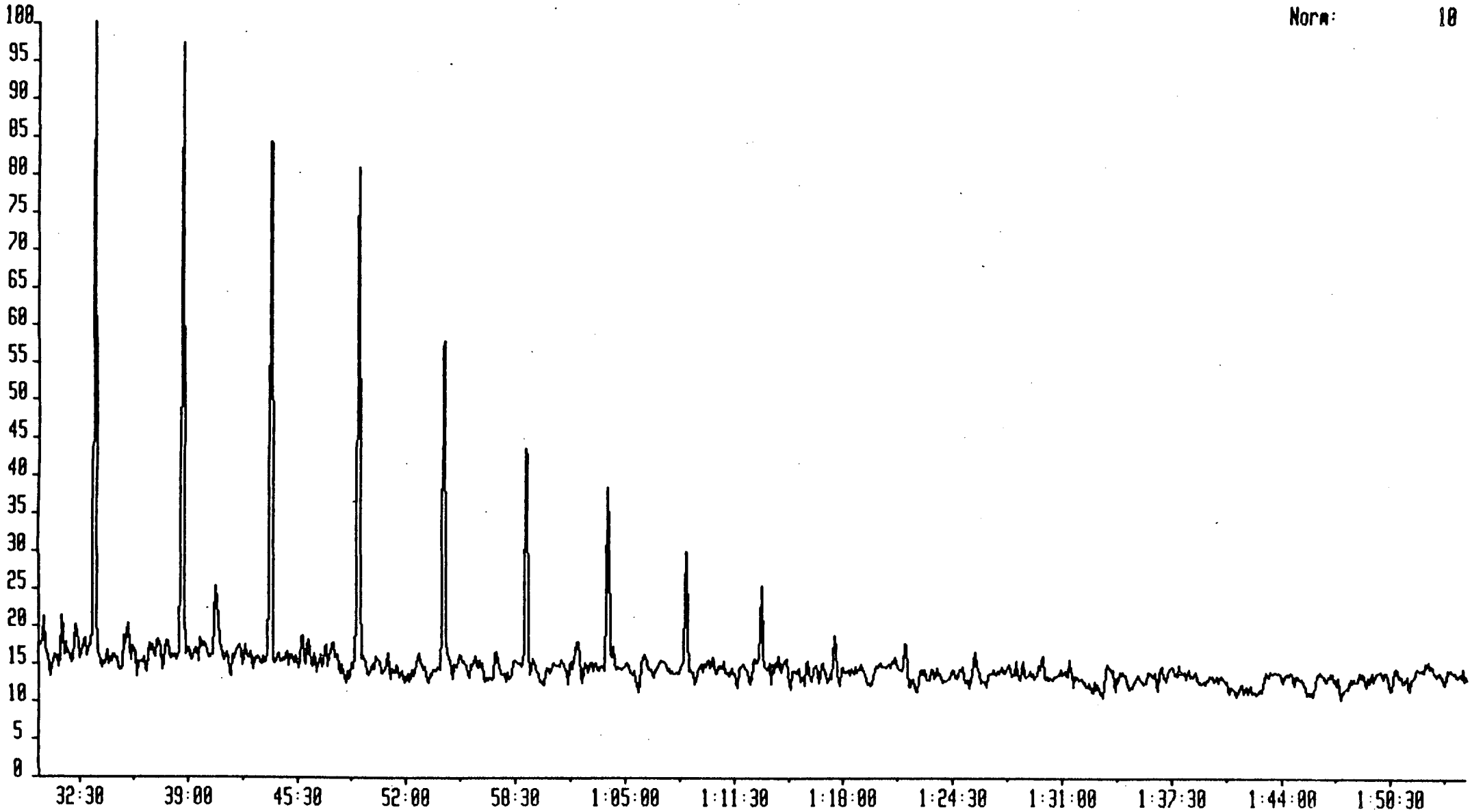
NB0309? 3-SEP-87 Sir:Voltage 70E Acqt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 177.1643
Text:30/9-6 DST#1

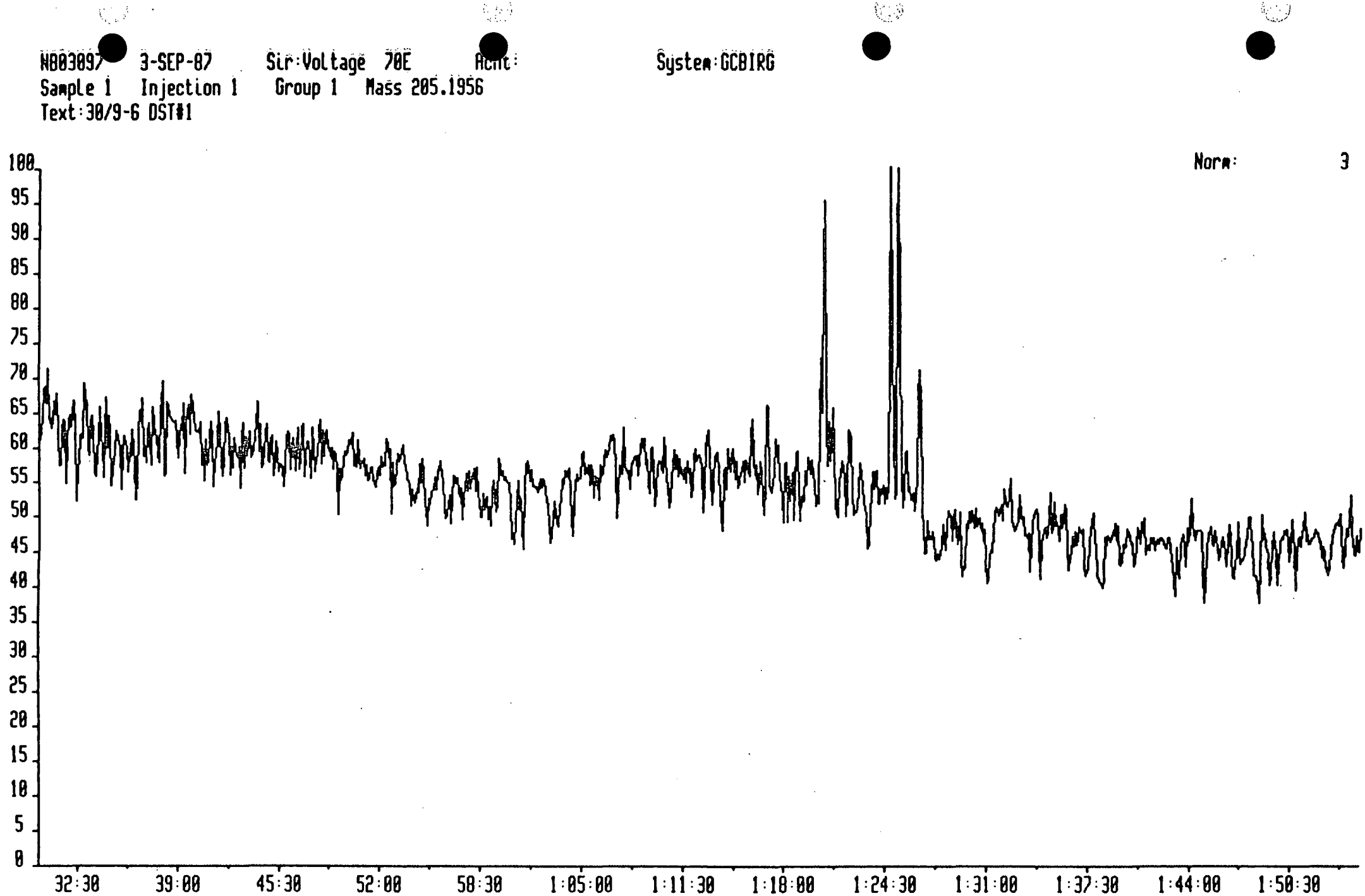


NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:30/9-6 DST#1

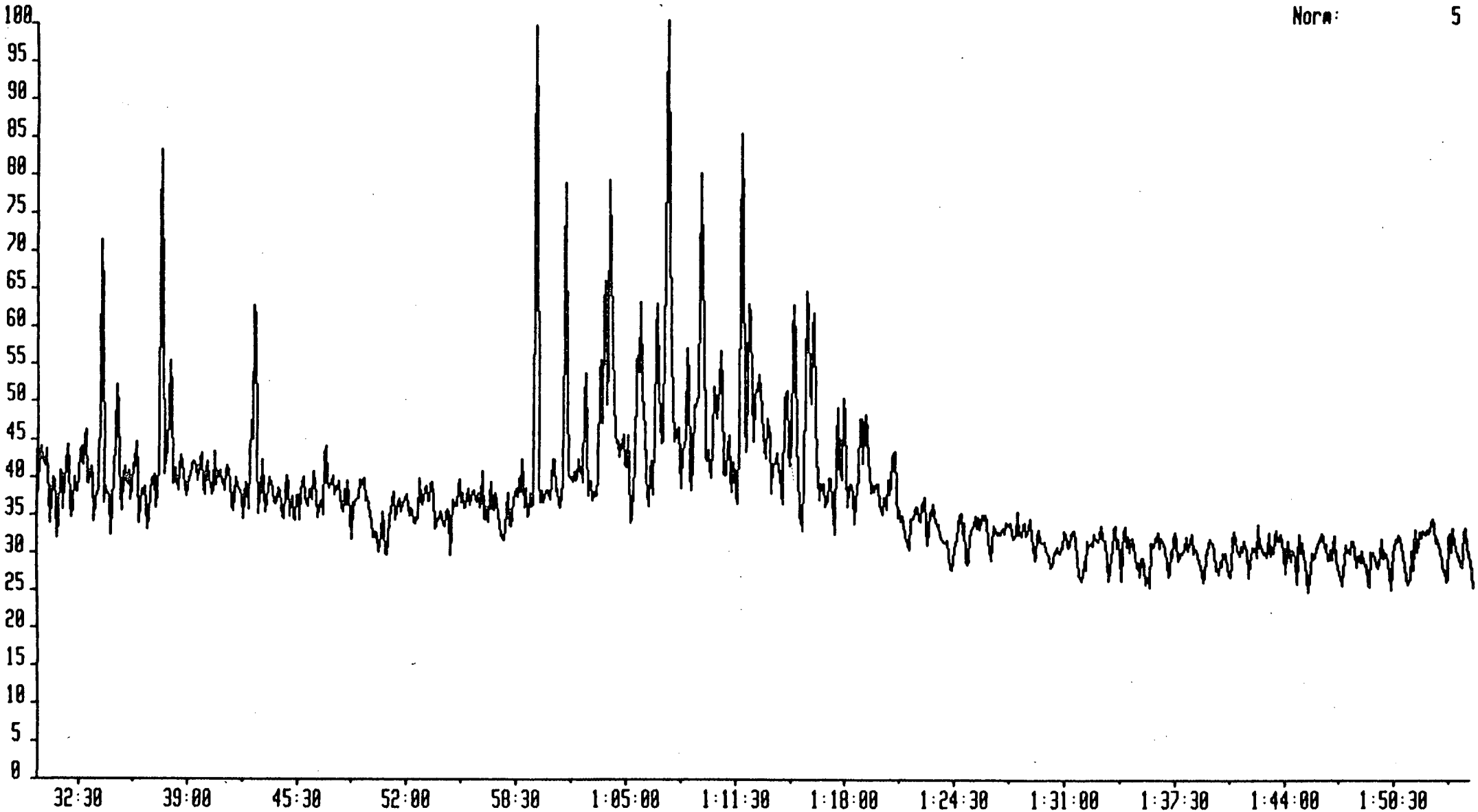


NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 197.2269
Text:30/9-6 DST#1

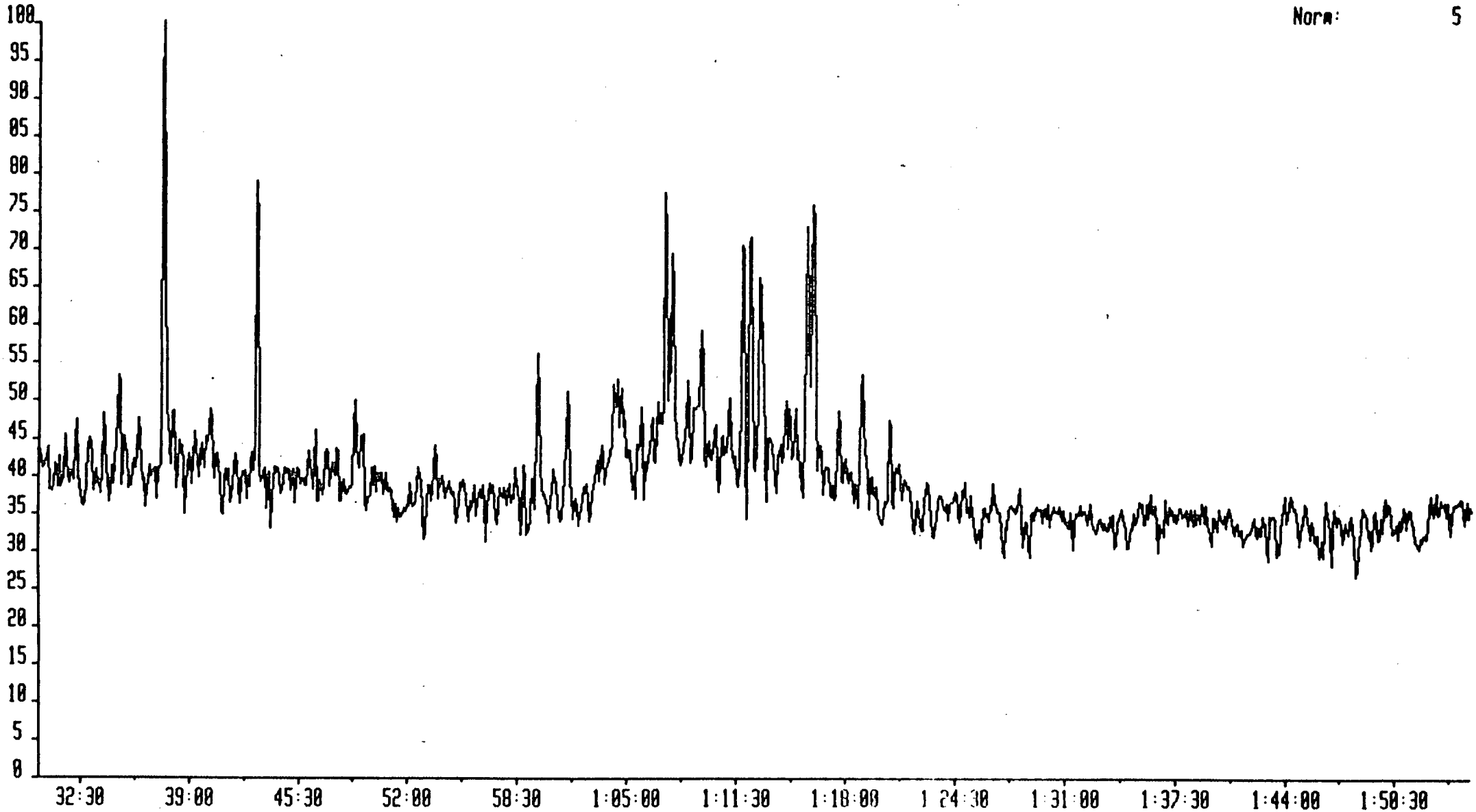


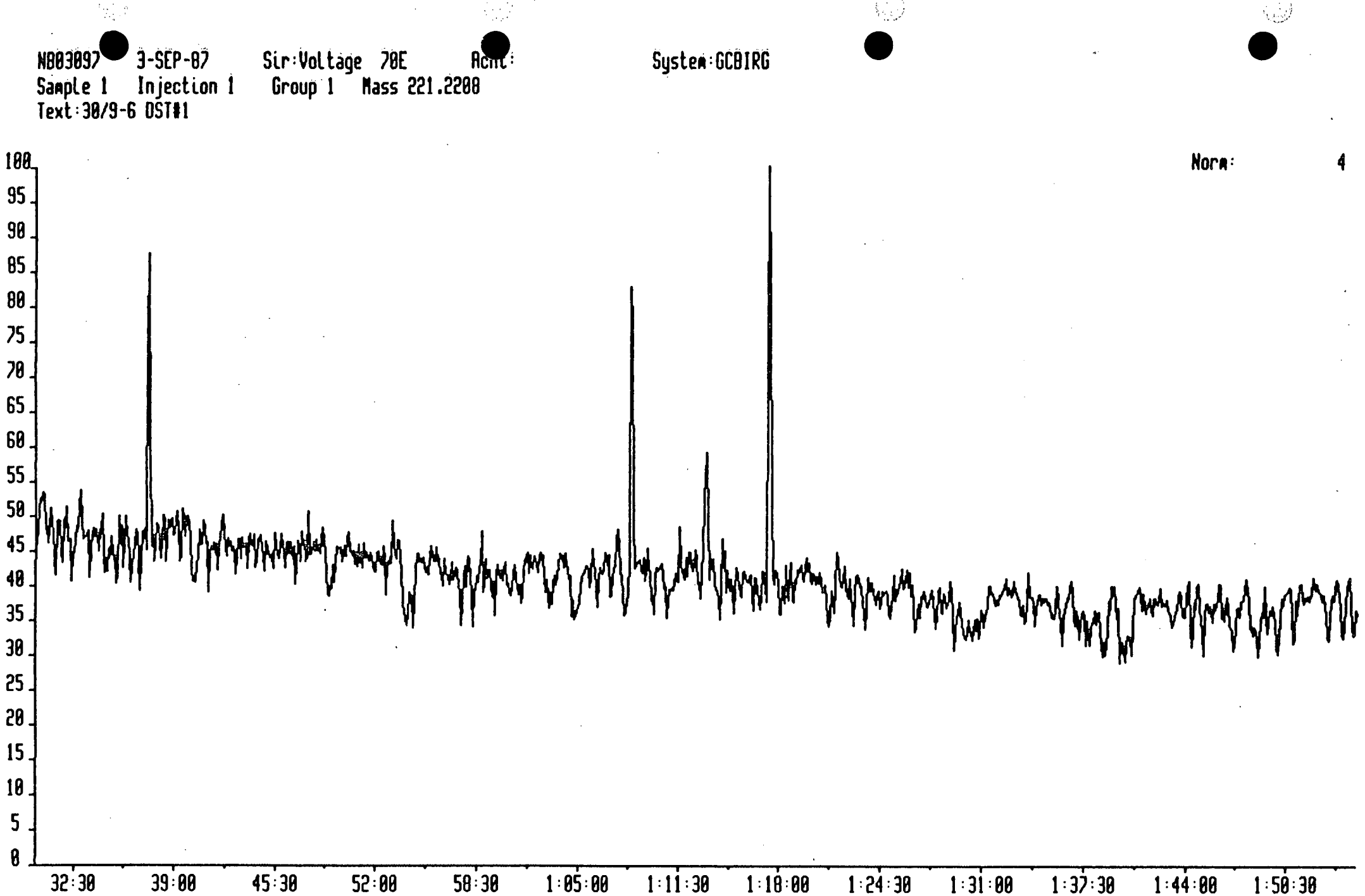

NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 205.1956
Text:30/9-6 DST#1
Norm: 3
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

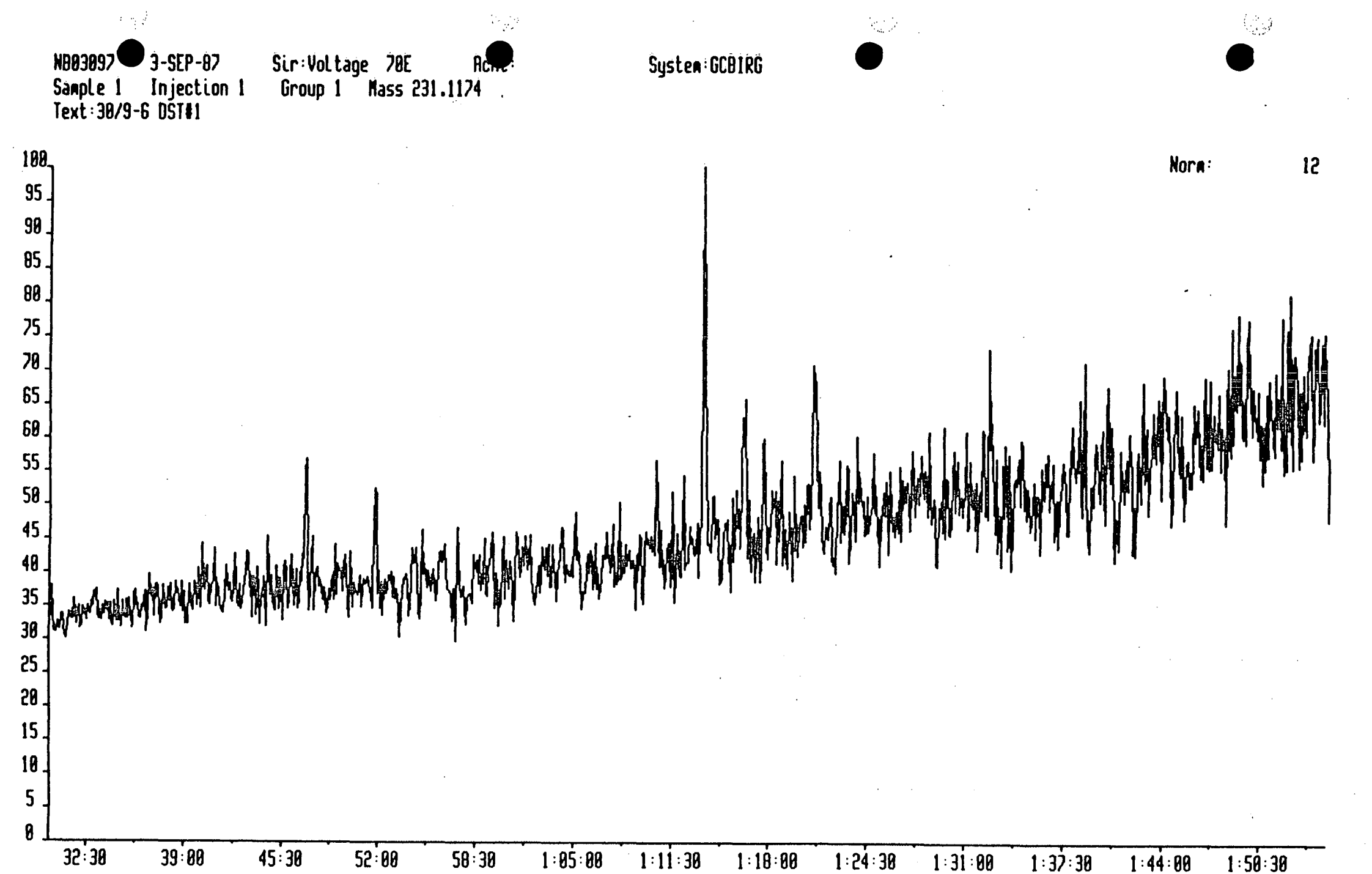
NB03097 3-SEP-87 Sir:Voltage 70E Acq: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 217.1956
Text:30/9-6 DST#1

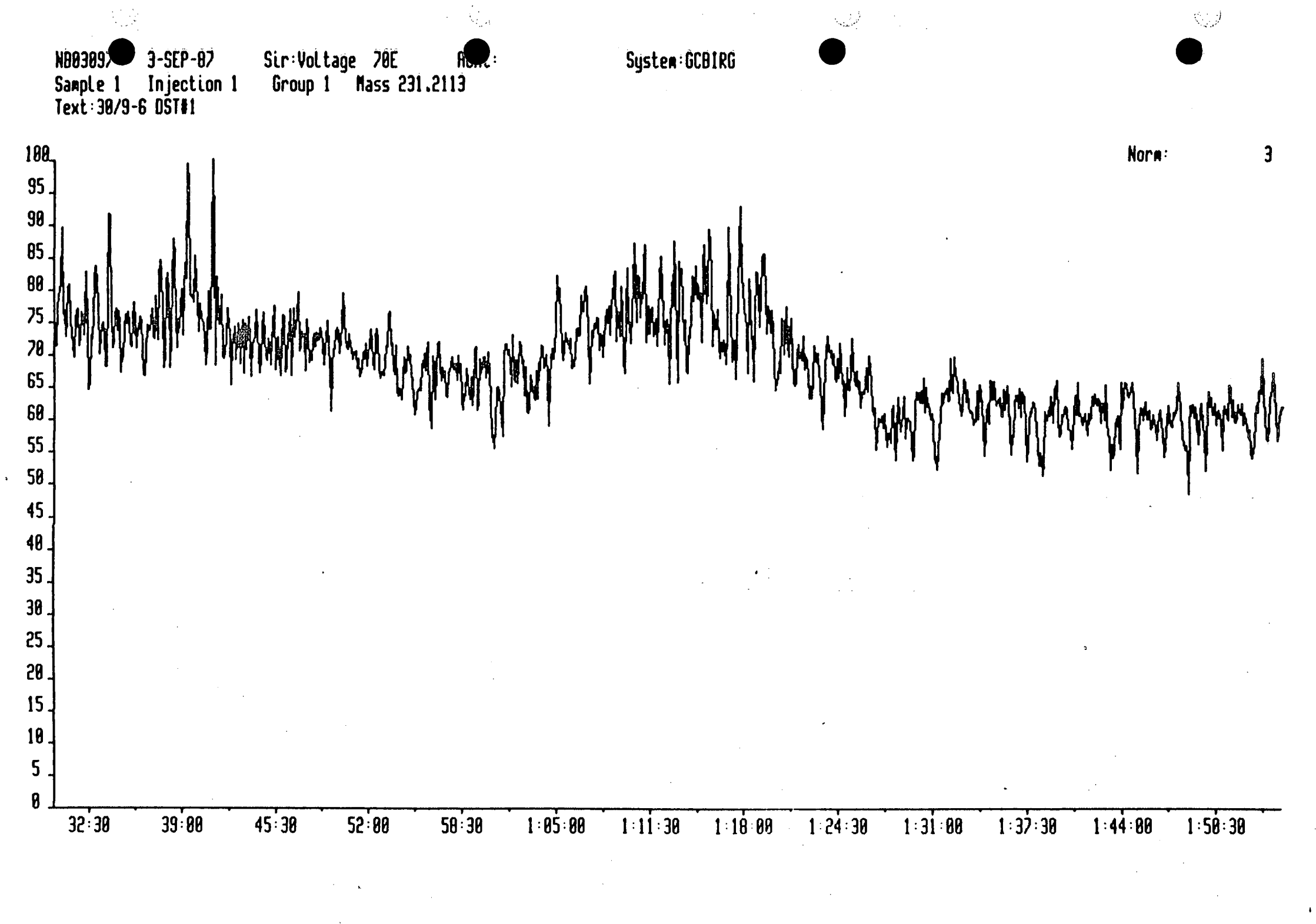


N803097 3-SEP-87 Sir:Voltage 70E Acq: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 218.2035
Text:30/9-6 DST#1

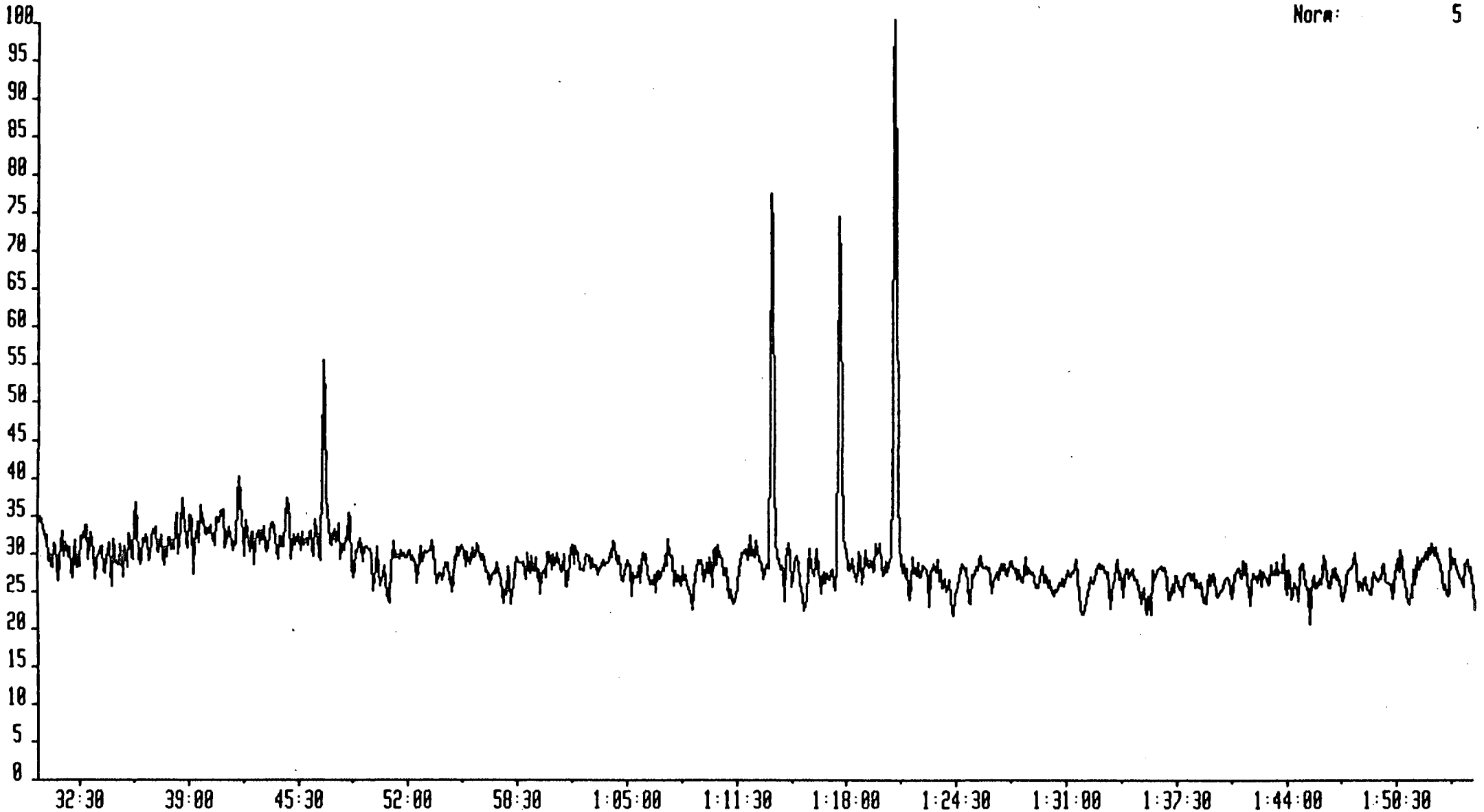


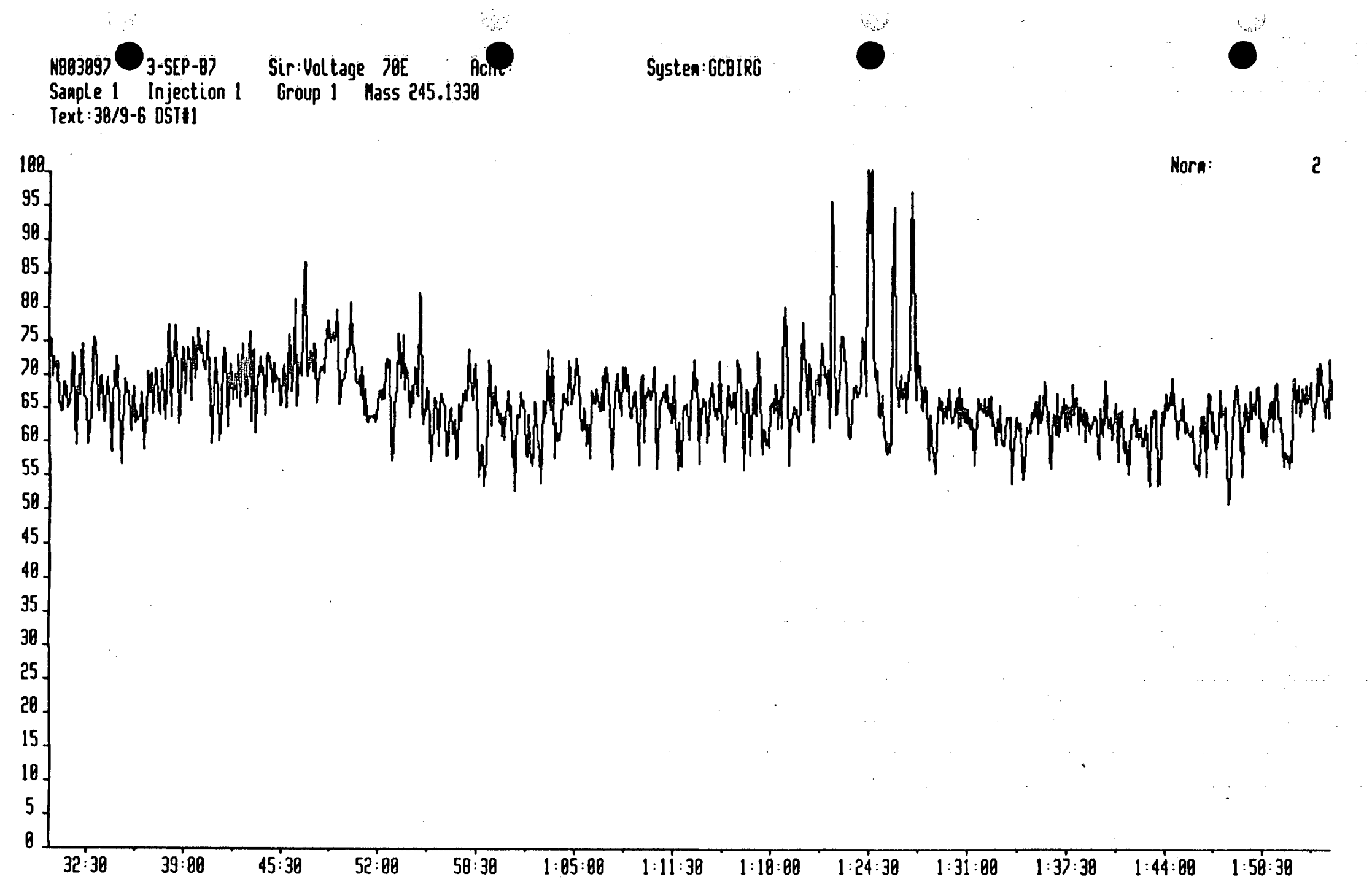

NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 221.2200
Text:30/9-6 DST#1
Norm: 4
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30


NB03097 3-SEP-87 Sir:Voltage 70E Acq: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 231.1174
Text:30/9-6 DST#1
Norm: 12
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

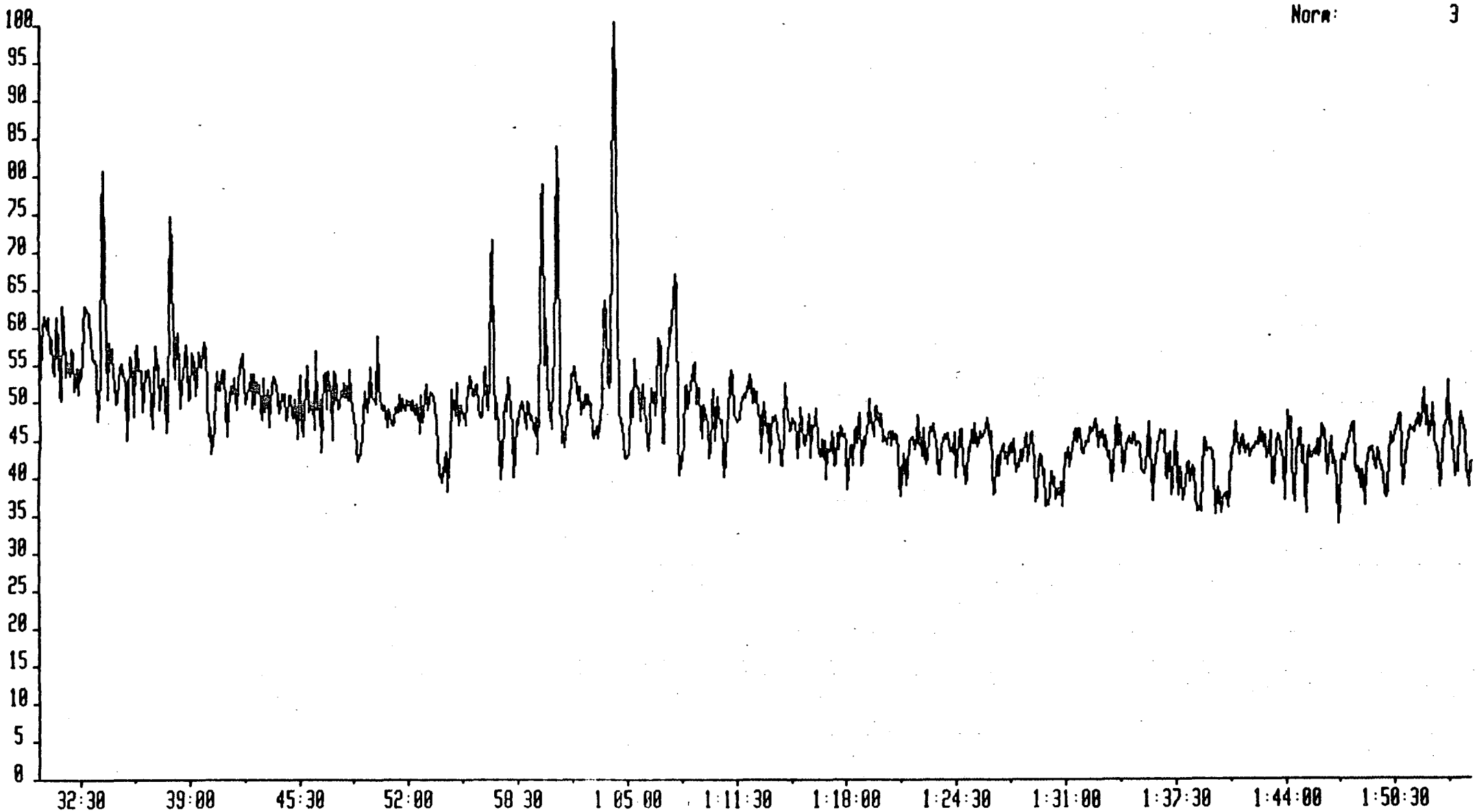

NB03097 3-SEP-87 Sir:Voltage 70E Acq:
System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 231.2113
Text:30/9-6 DST#1
Norm: 3
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

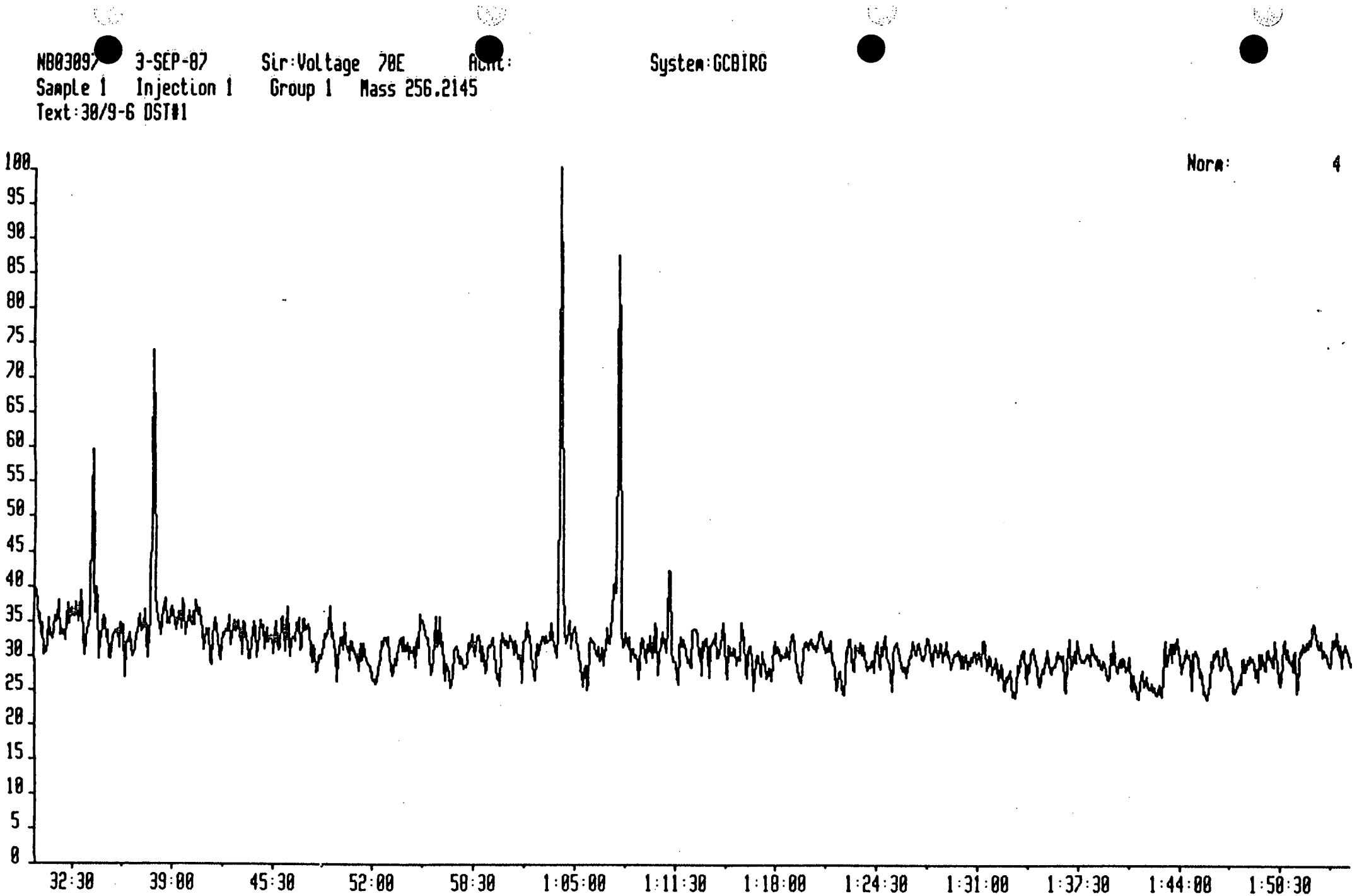
NB03097 3-SEP-87 Sir:Voltage 70E Acne: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 233.1299
Text:30/9-6 DST#1

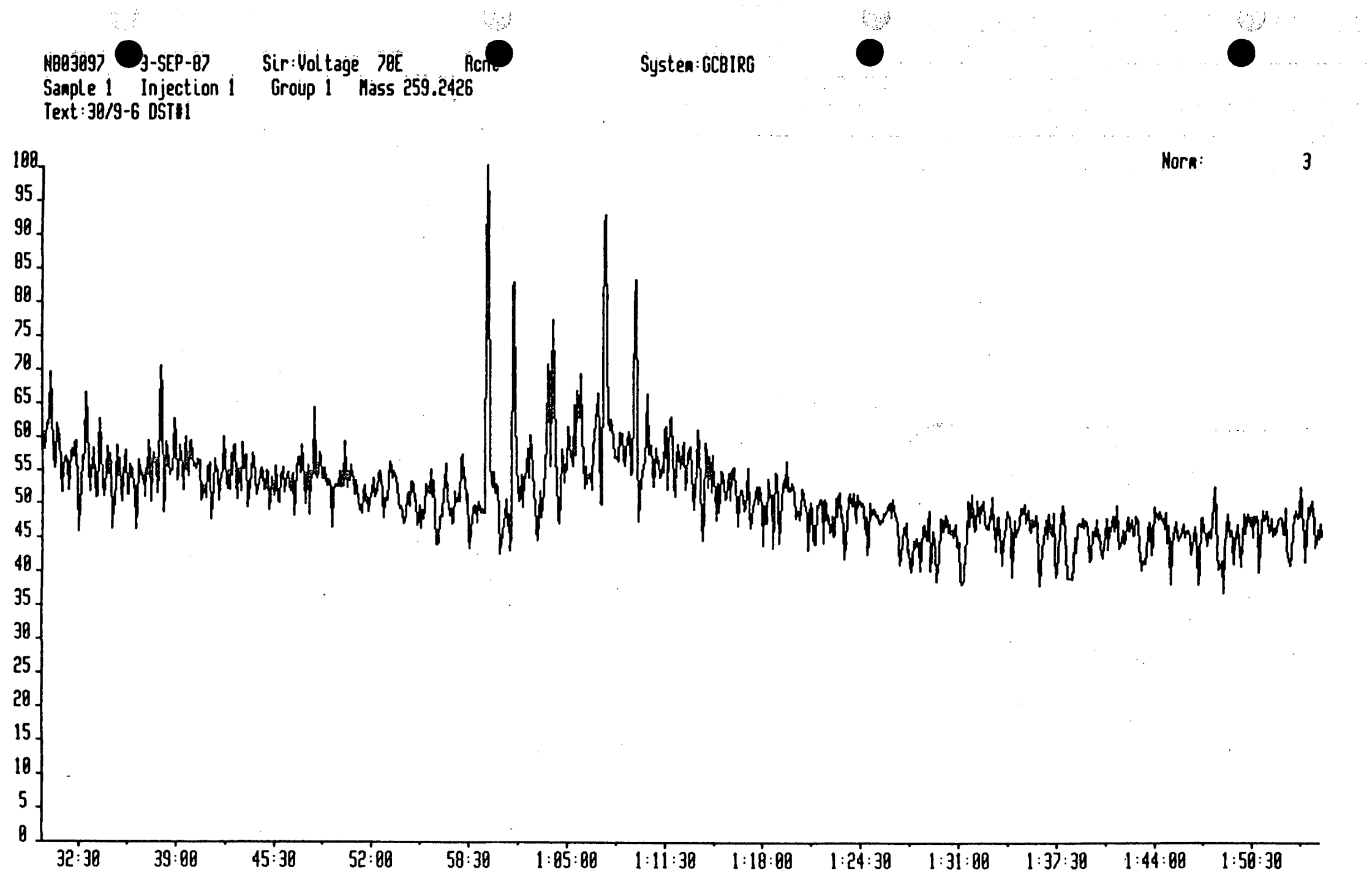



NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 245.1330
Text:30/9-6 DST#1
Norm: 2
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

N80309? 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 253.1956
Text:30/9-6 OST#1



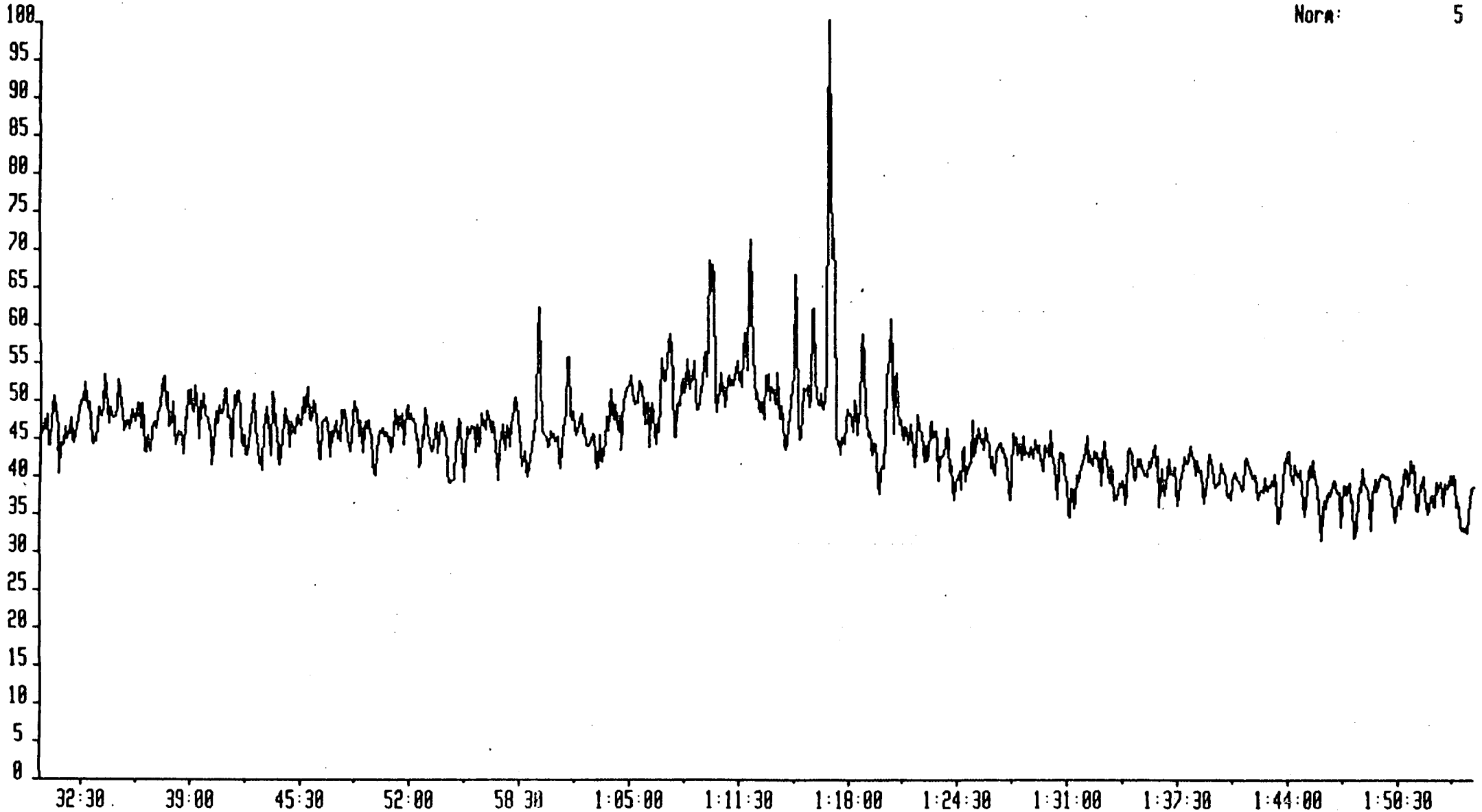

NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 256.2145
Text:30/9-6 DST#1
Norm: 4
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30


N803097 3-SEP-87 Sir:Voltage 70E Acne System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 259.2426
Text:30/9-6 DST#1
Norm: 3
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

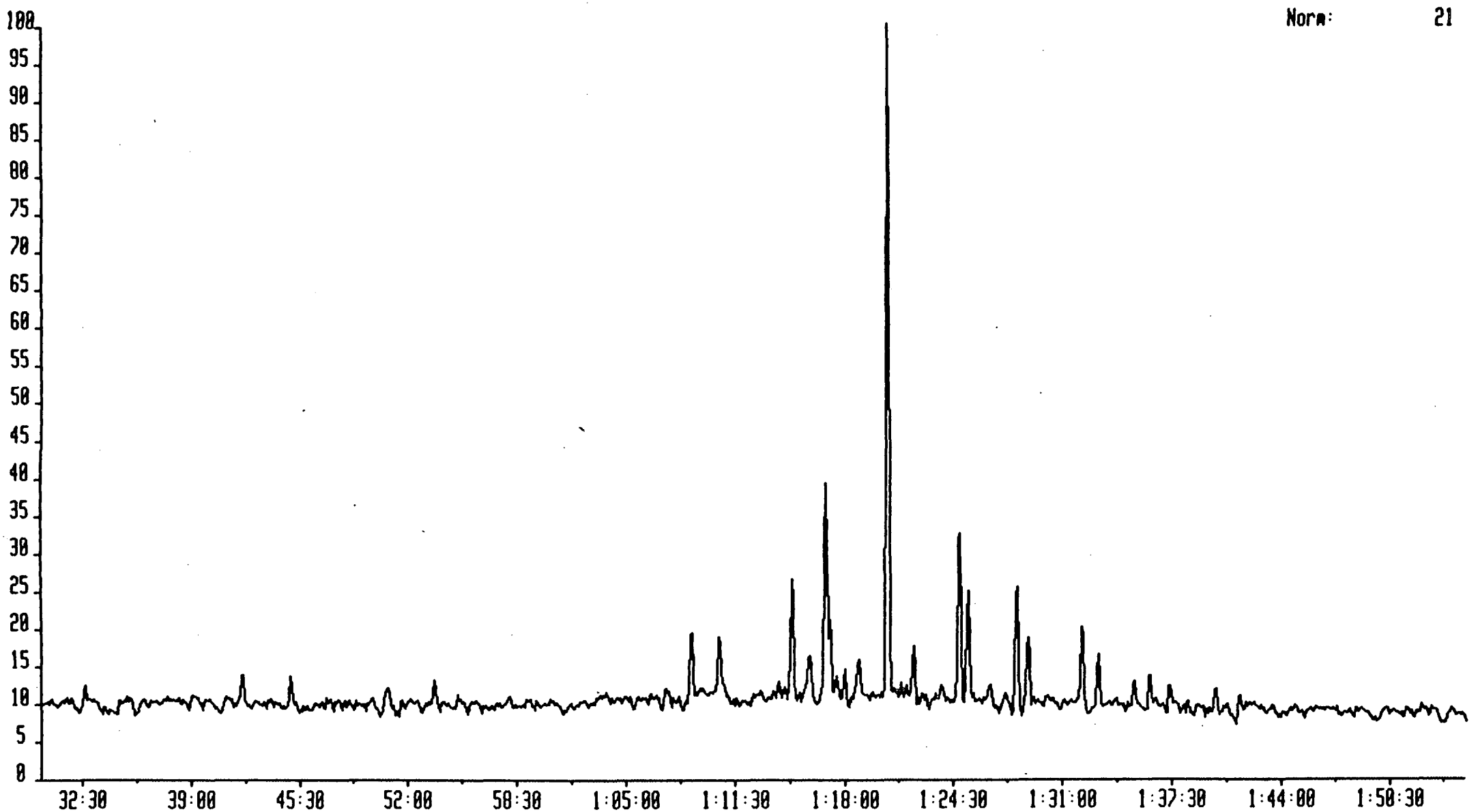
HIGH RESOLUTION MASS FRAGMENTOGRAMS

WELL 30/9-6, DST 2

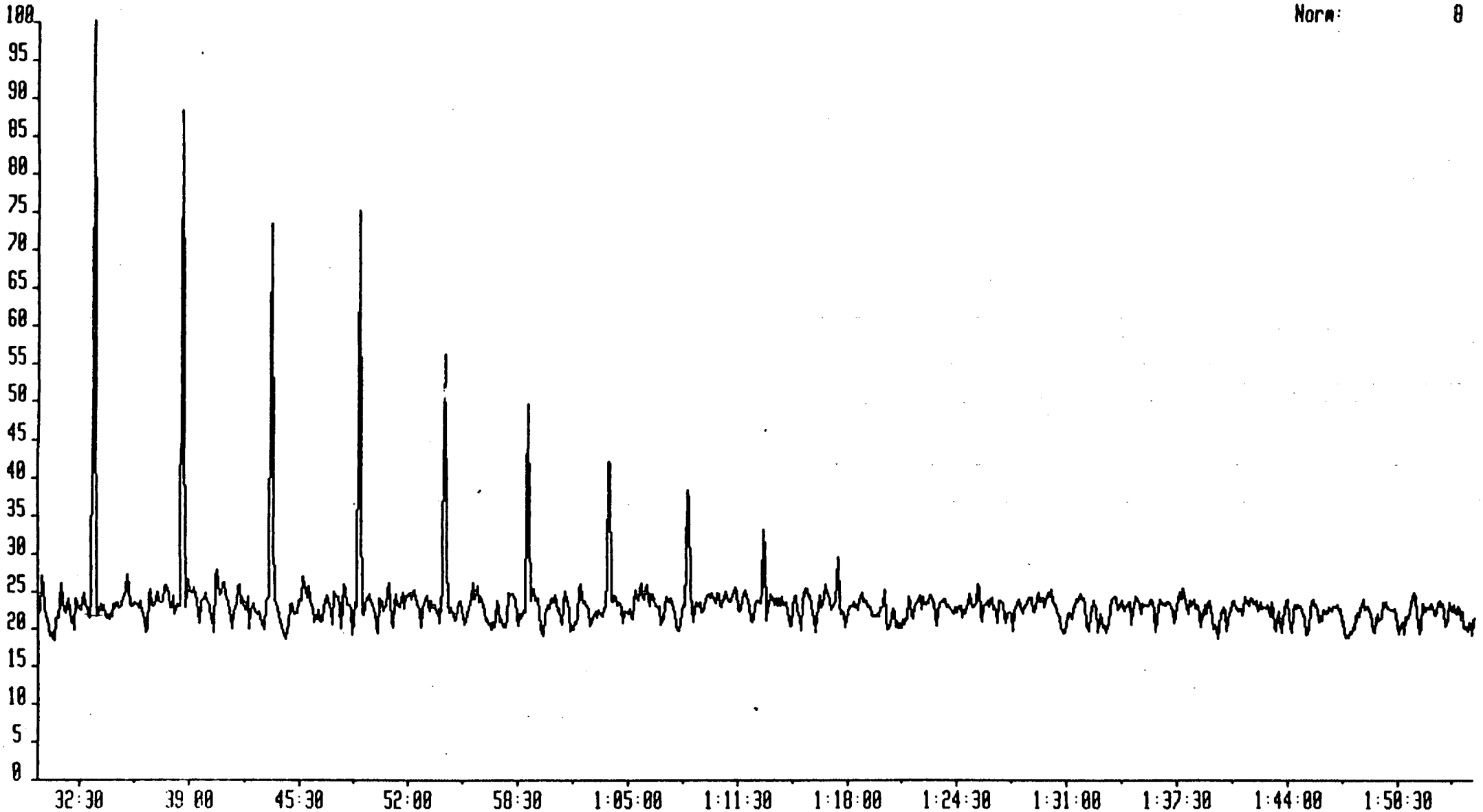
NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 177.1643
Text:30/9-6 DST#2



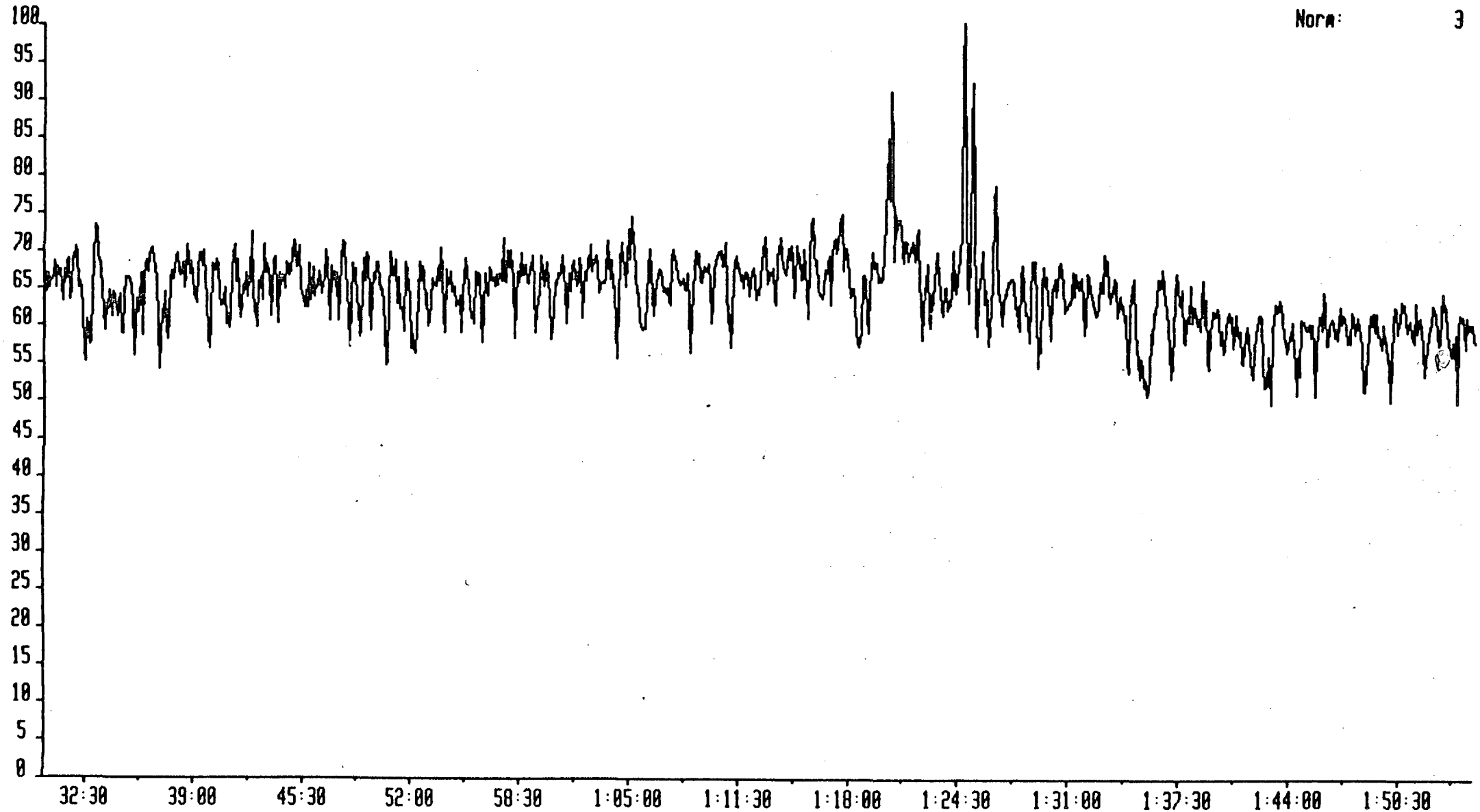
NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 191.1000
Text:30/9-6 DST#2



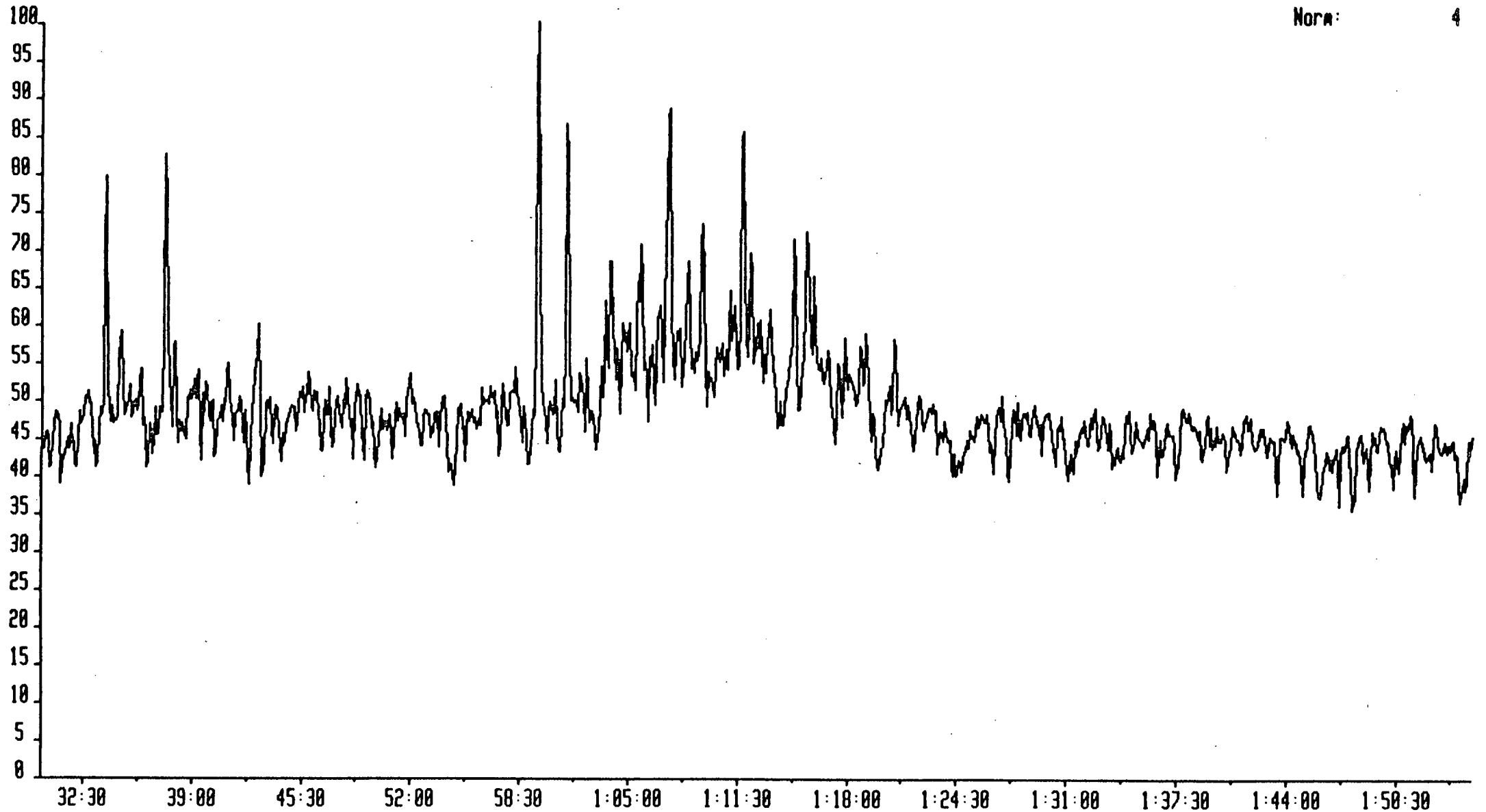
N80309? 3-SEP-87 Sir:Voltage 70E Ment: Systen:GCBIRG
Sample 2 Injection 1 Group 1 Mass 197.2269
Text:30/9-6 DST#2

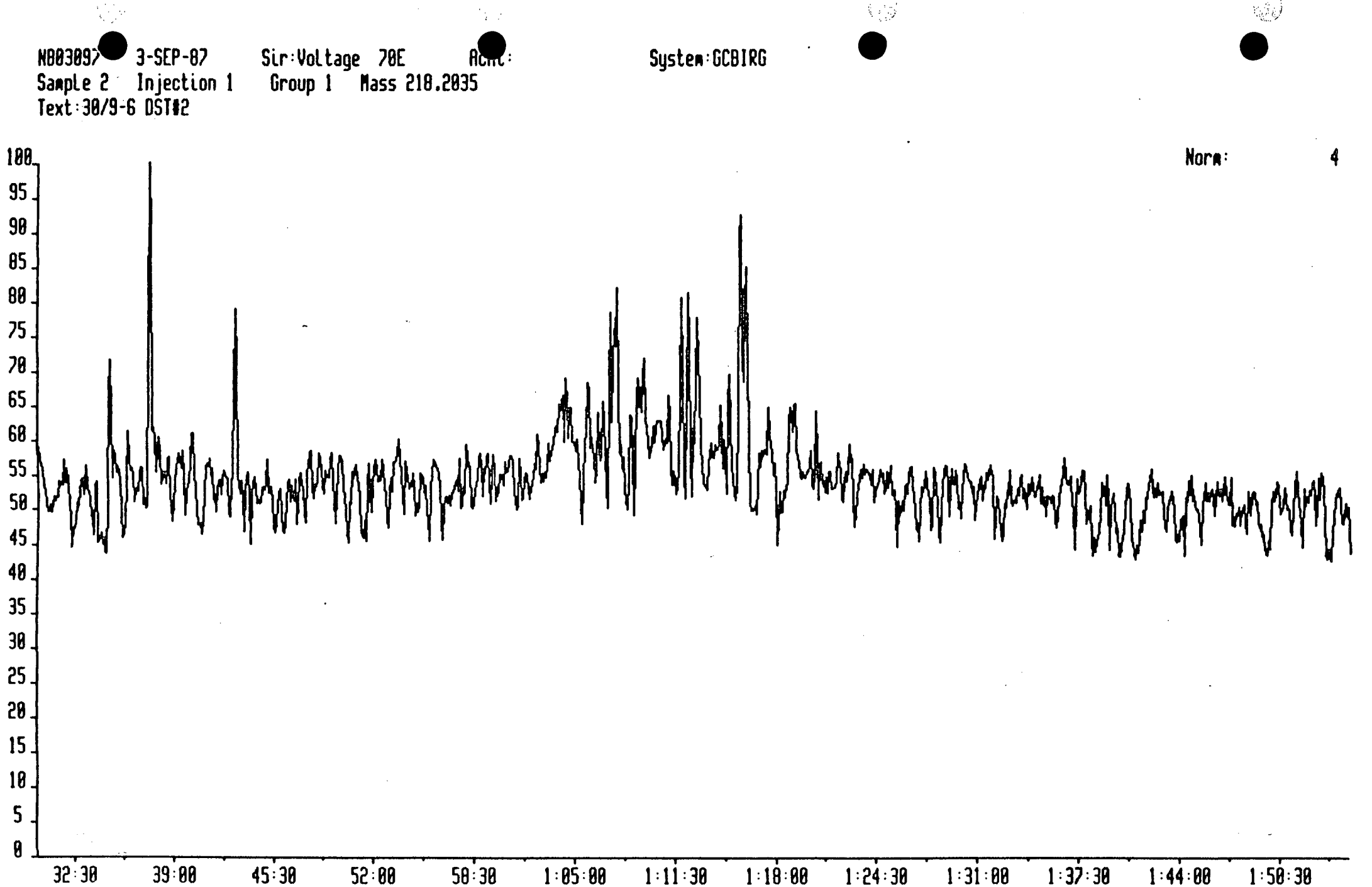


M80309? 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 205.1956
Text:30/9-6 DST#2

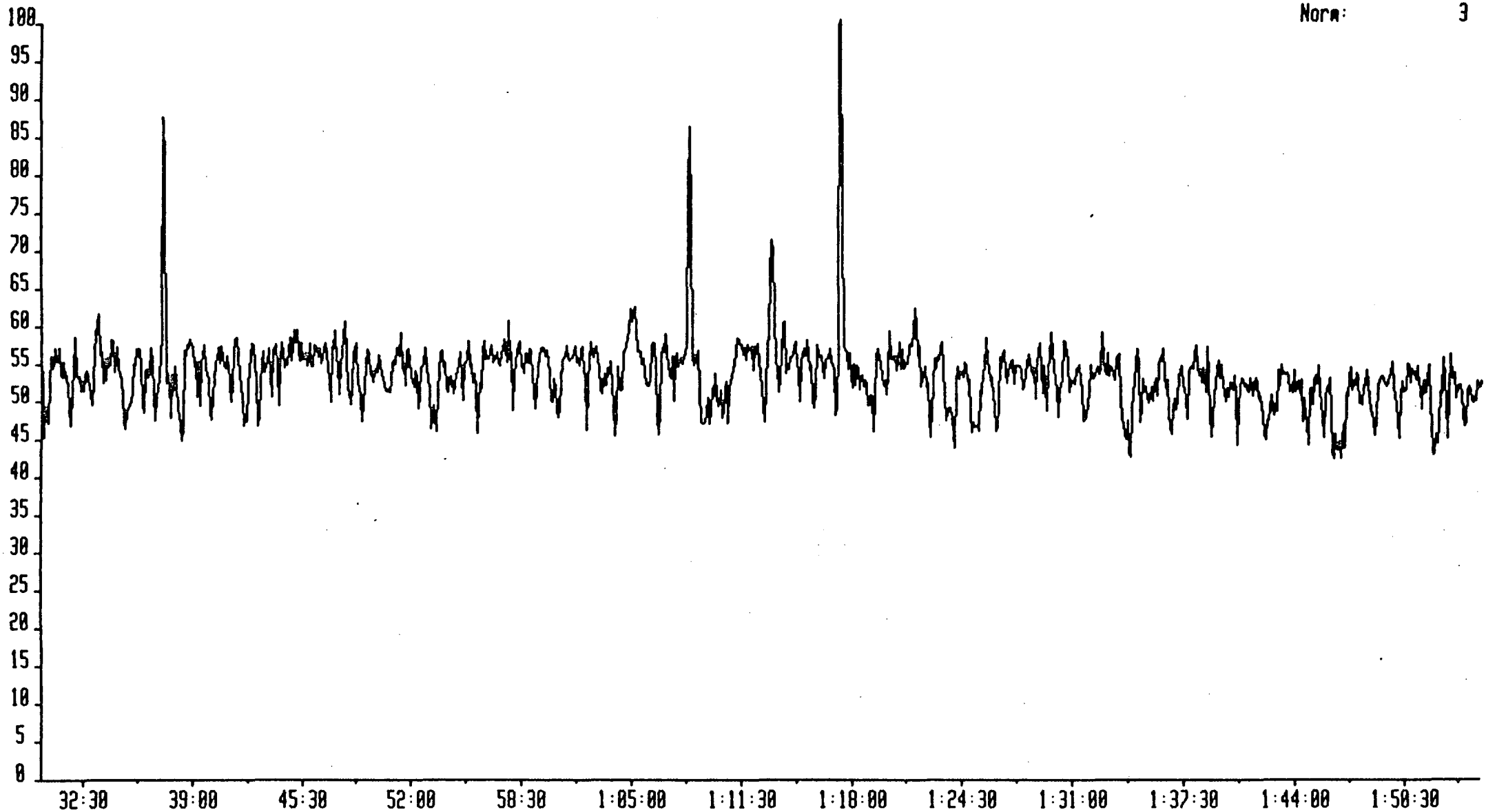


NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 217.1956
Text:30/9-6 DST#2

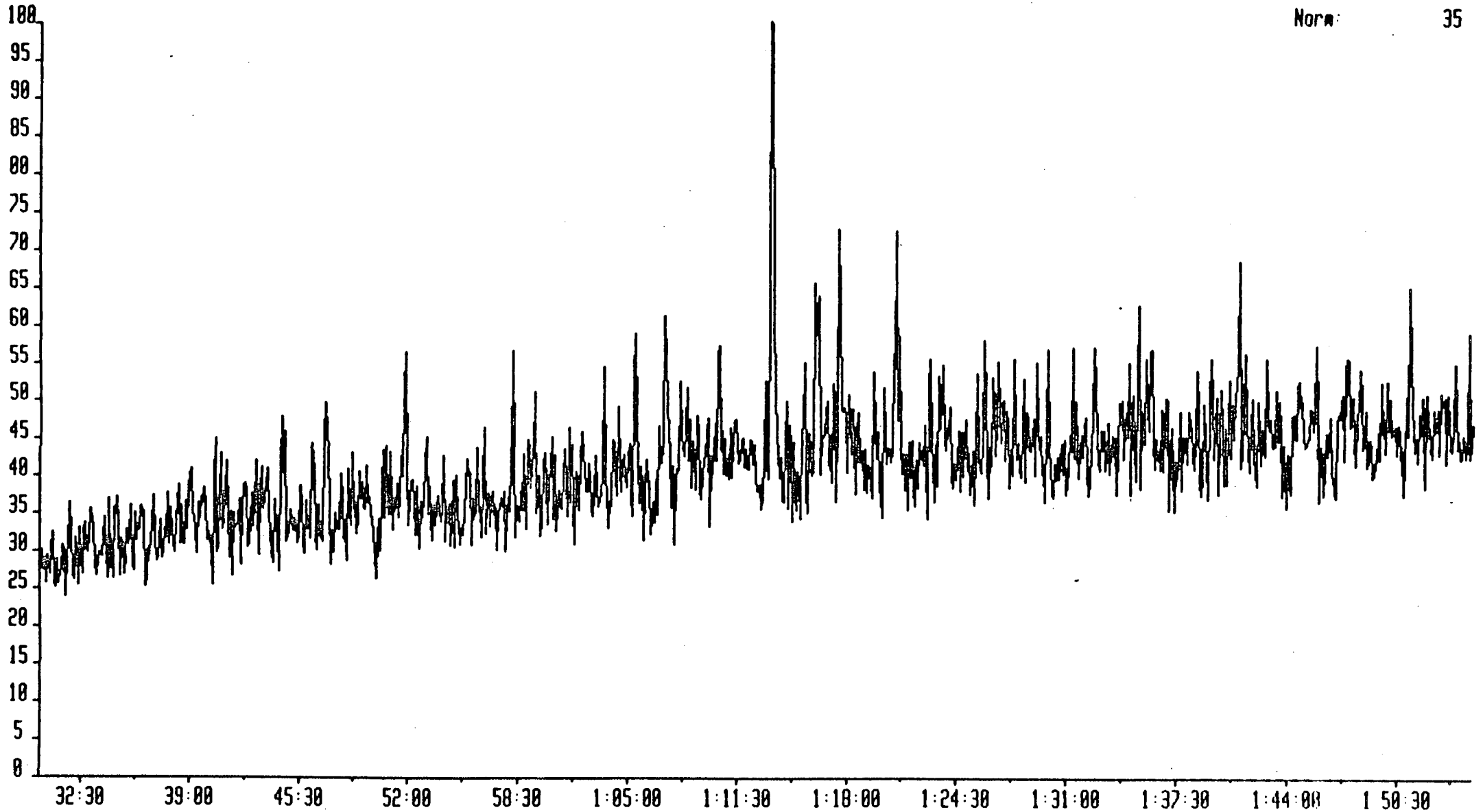



M803097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 218.2035
Text:30/9-6 DST#2
Norm: 4
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

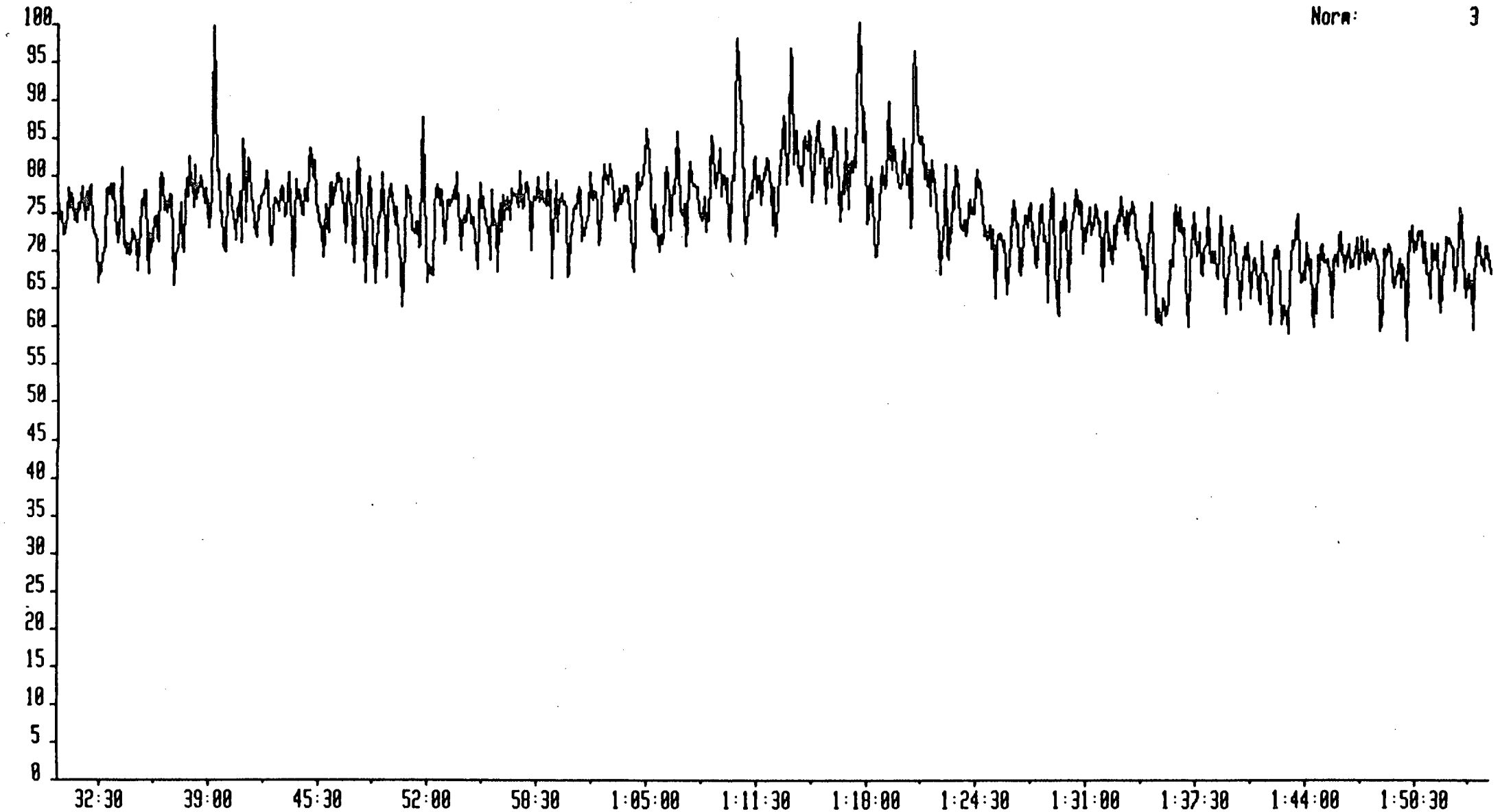
N803097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 221.2208
Text:30/9-6 DST#2



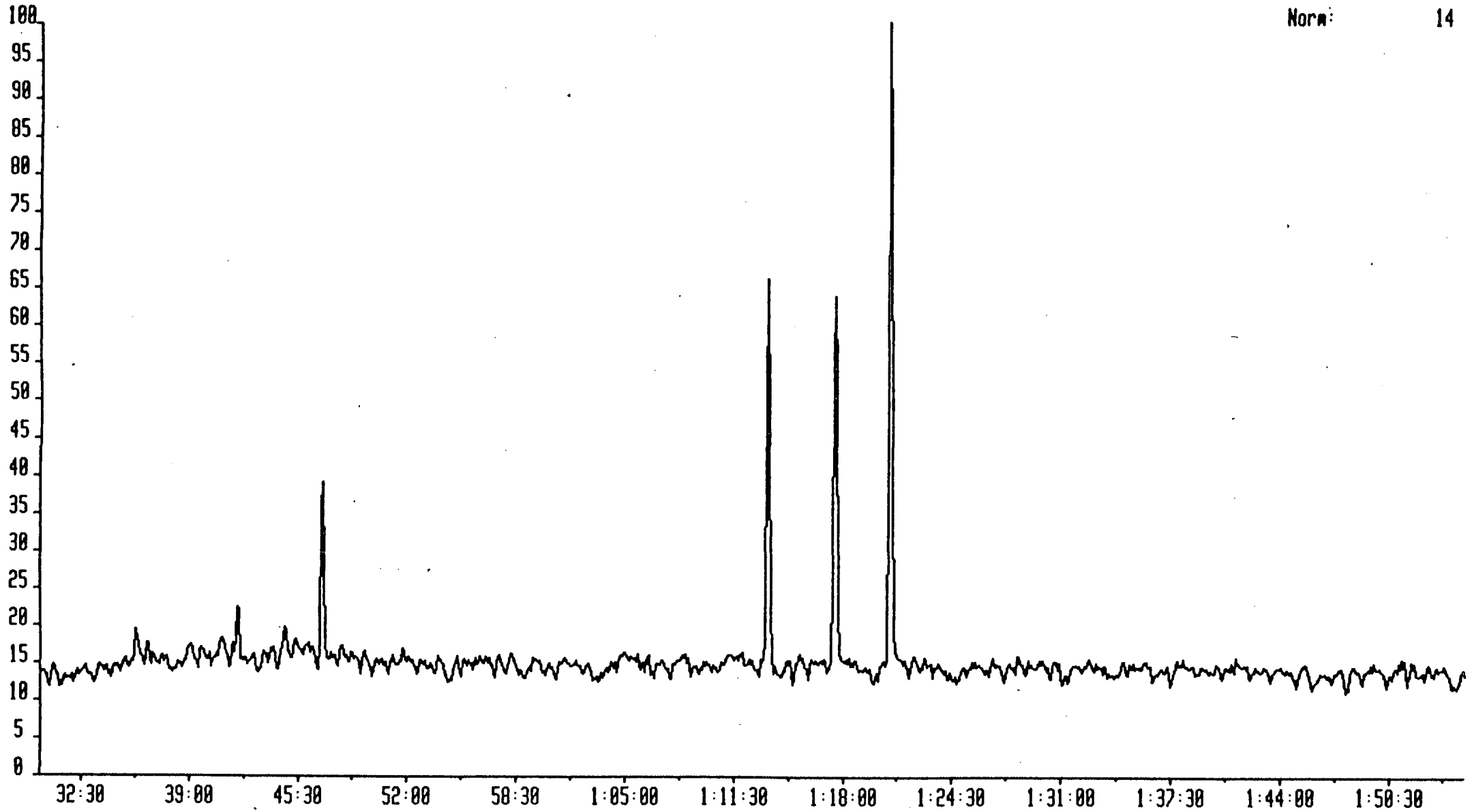
NB03097 3-SEP-87 Sir:Voltage 70E Acnc: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 231.1174
Text:30/9-6 DST#2

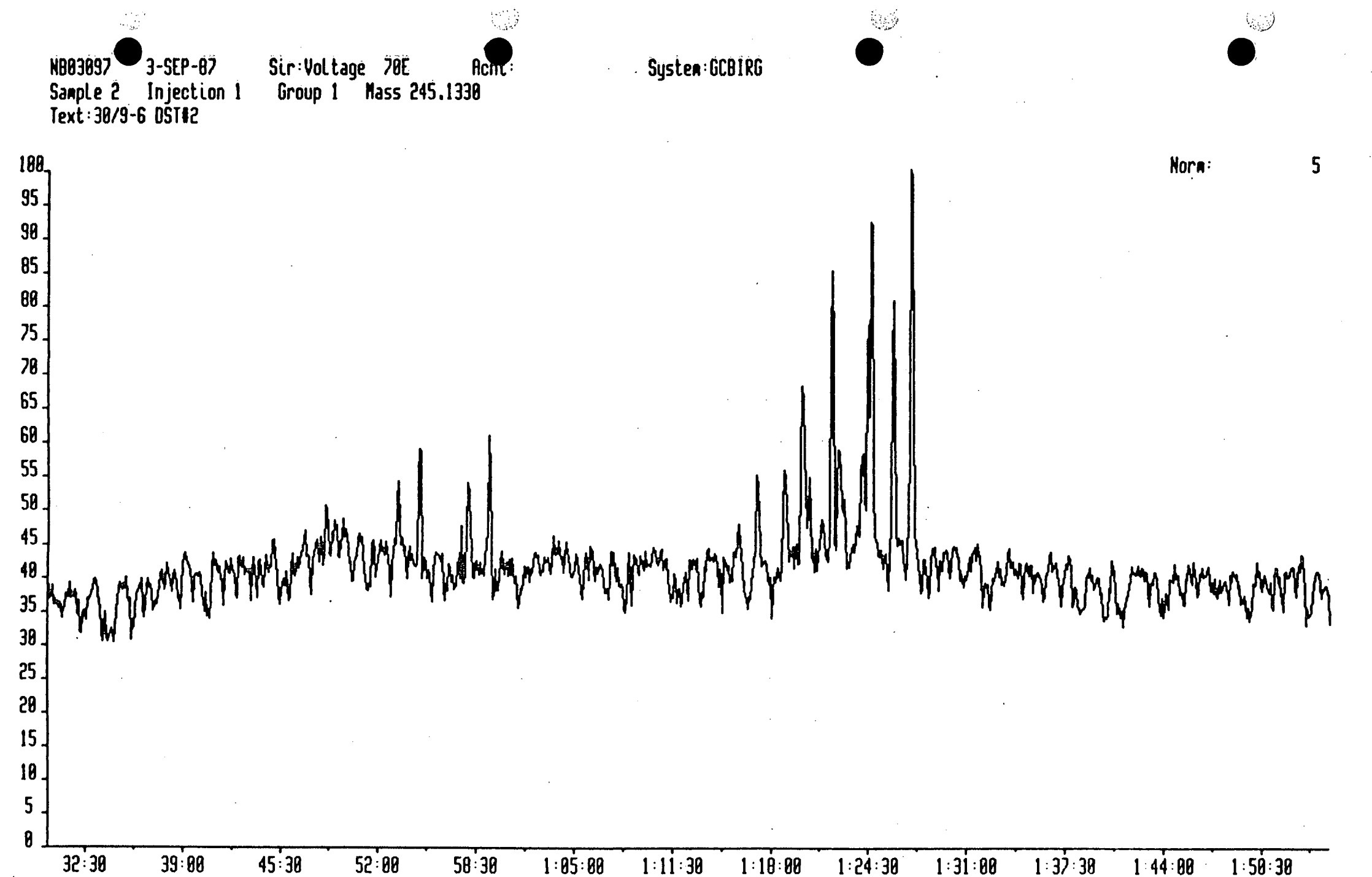


NB03097 3-SEP-87 Sir:Voltage 70E Acq: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 231.2113
Text:30/9-6 DST#2

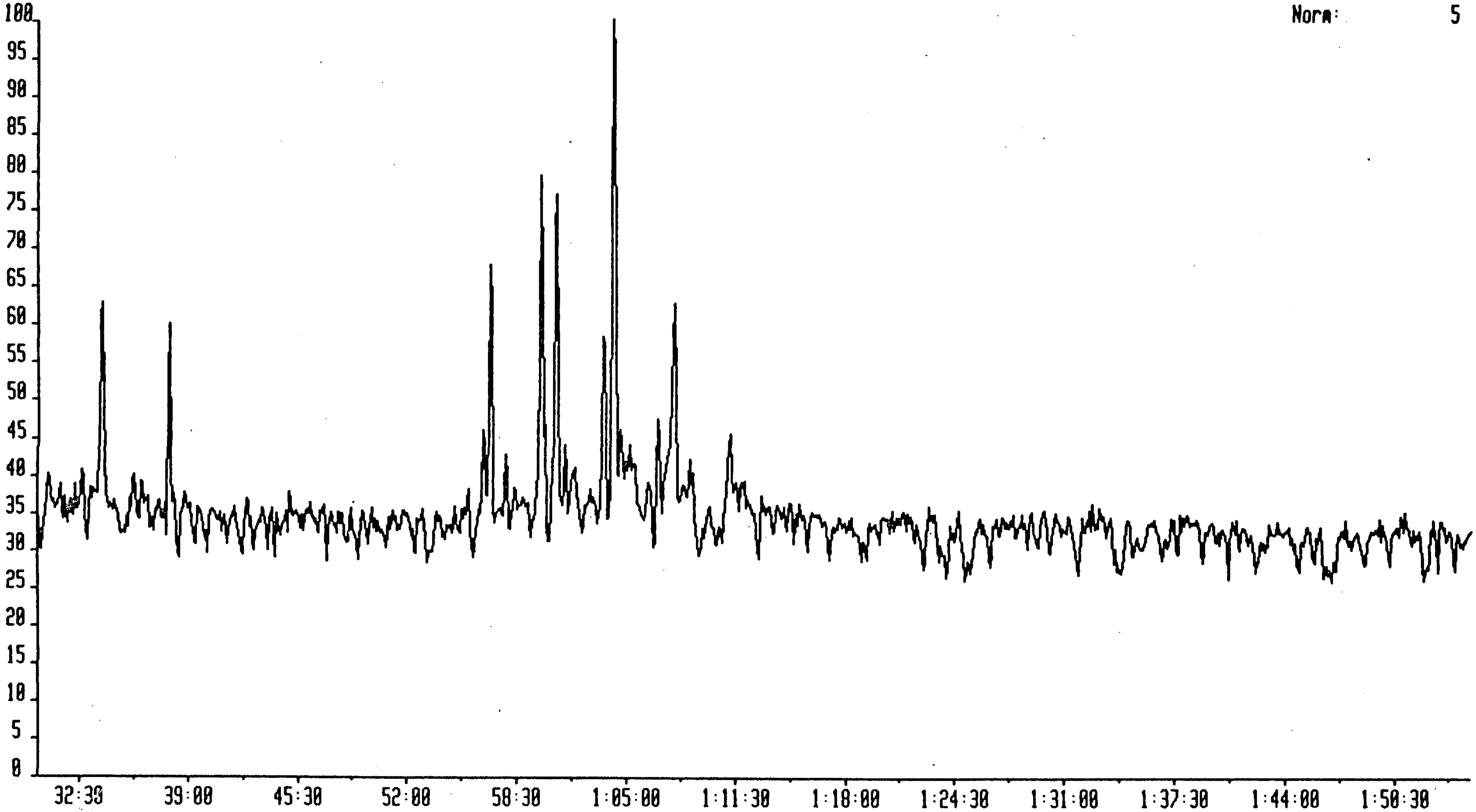


N003097 3-SEP-07 Sir:Voltage 70E Asmt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 233.1299
Text:30/9-6 DST#2

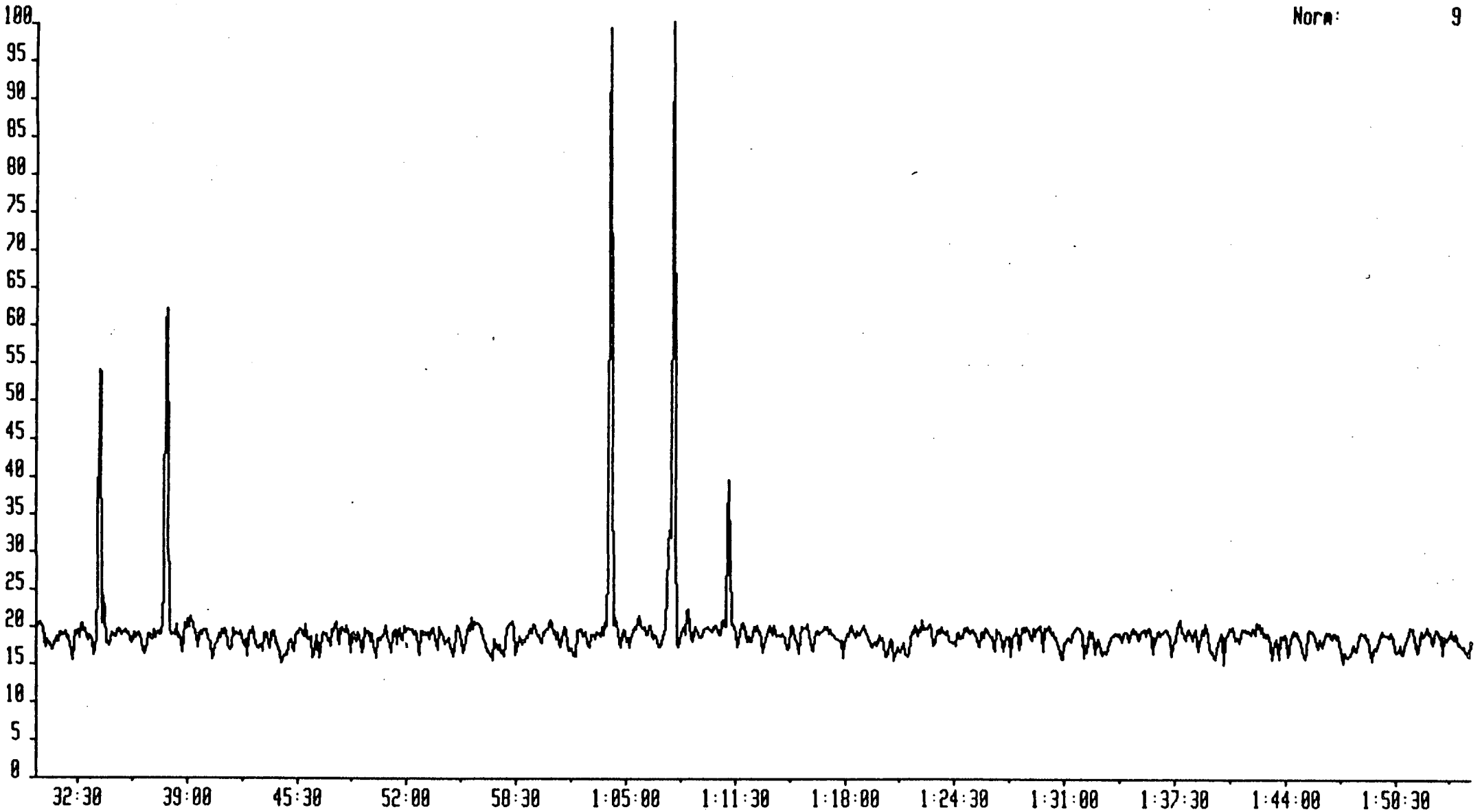


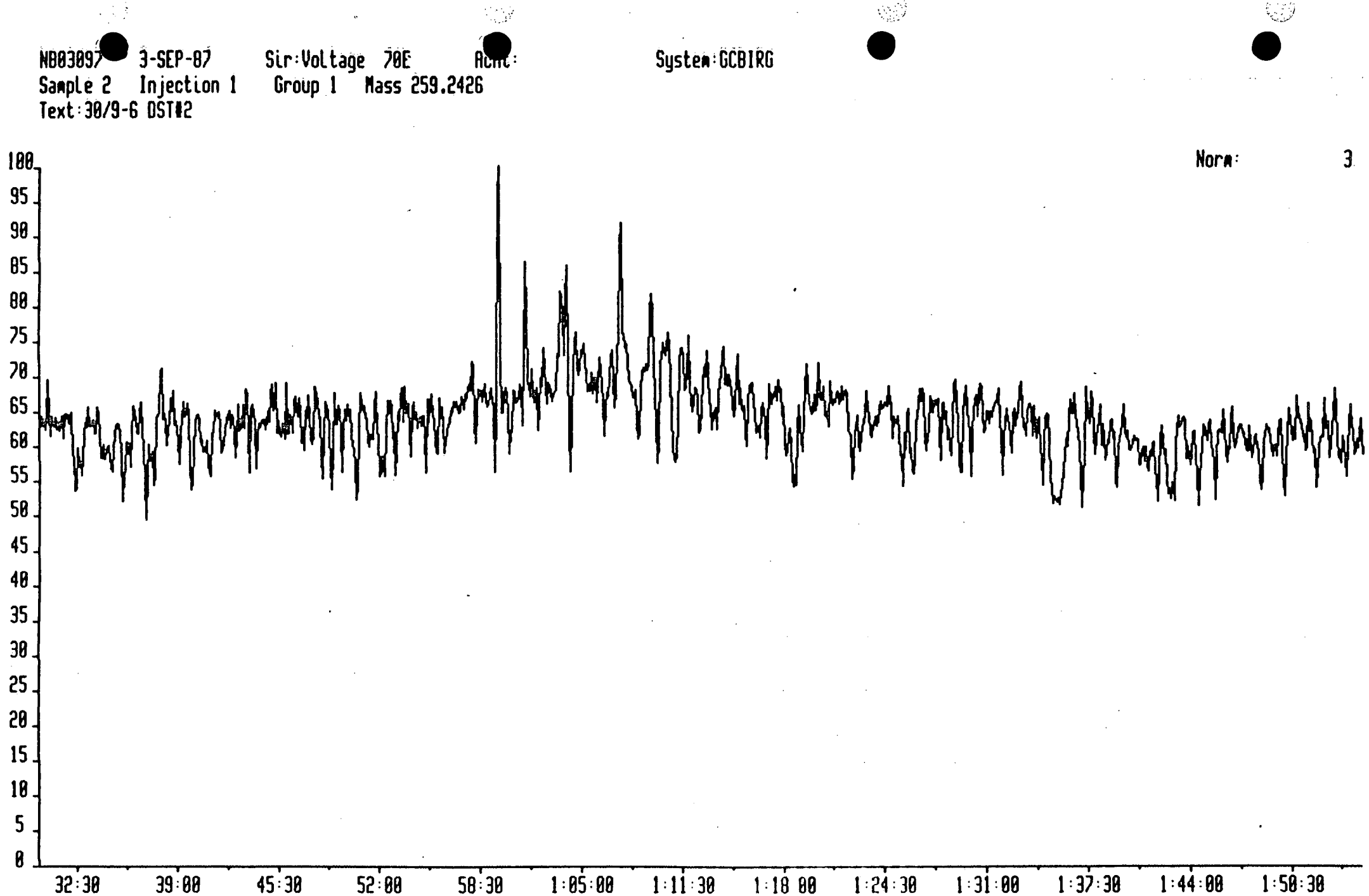

NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 245.1330
Text:30/9-6 DST#2
Norm: 5
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18:00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

NB0309 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 253.1956
Text:30/9-6 DST#2



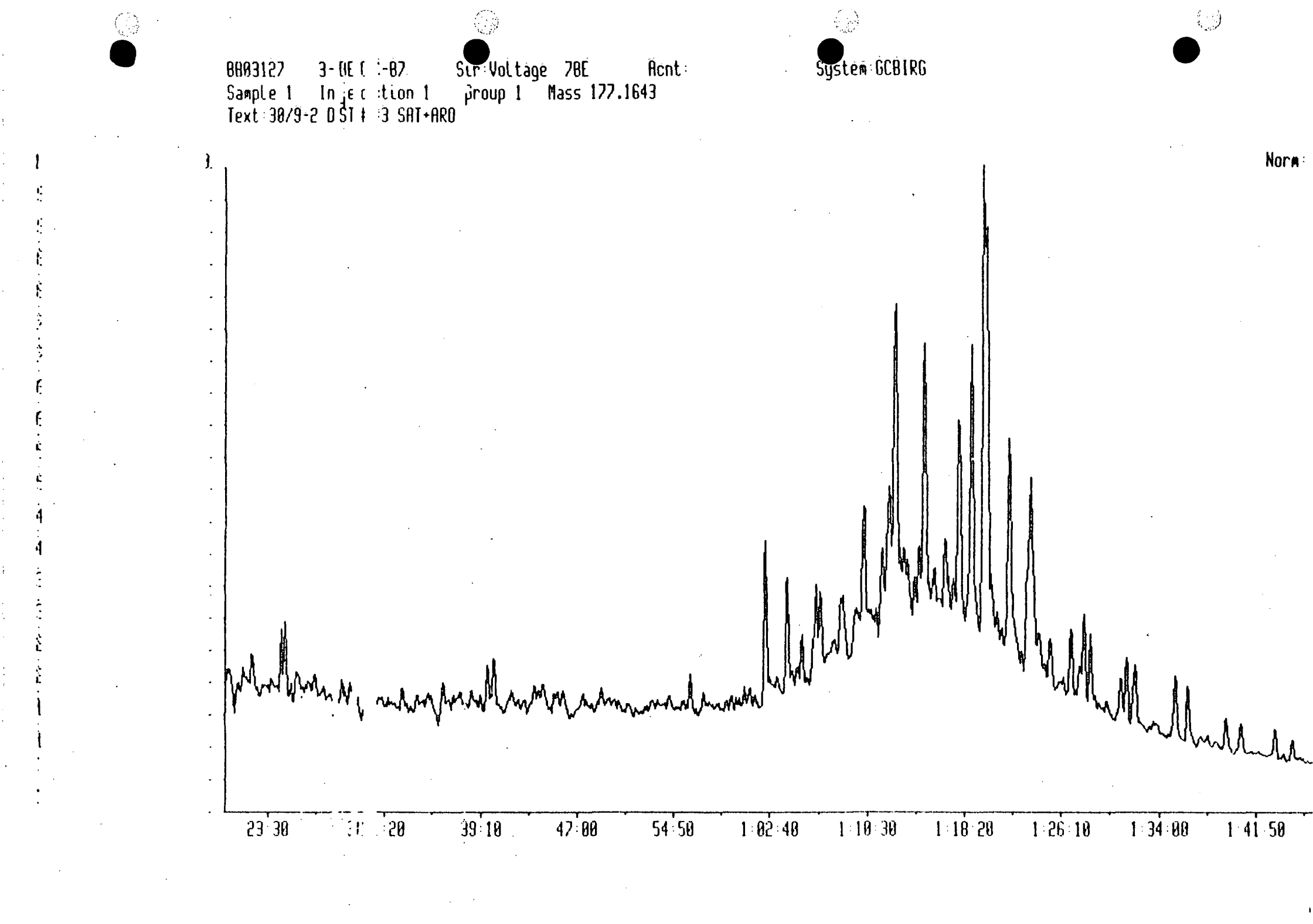
NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 256.2145
Text:30/9-6 DST#2

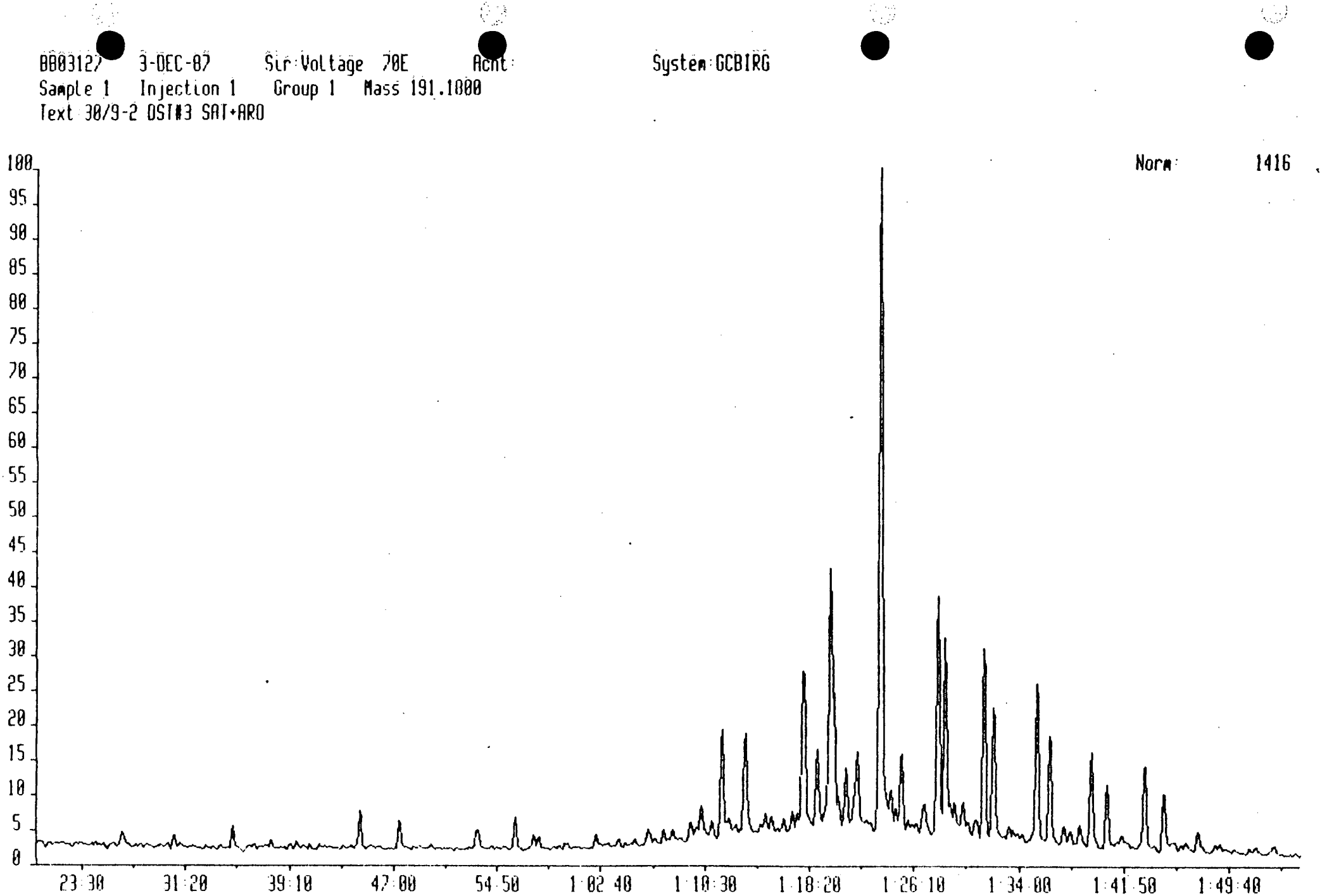



NB03097 3-SEP-87 Sir:Voltage 70E Acnt: System:GCBIRG
Sample 2 Injection 1 Group 1 Mass 259.2426
Text:30/9-6 DST#2
Norm: 3
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
32:30
39:00
45:30
52:00
58:30
1:05:00
1:11:30
1:18 00
1:24:30
1:31:00
1:37:30
1:44:00
1:50:30

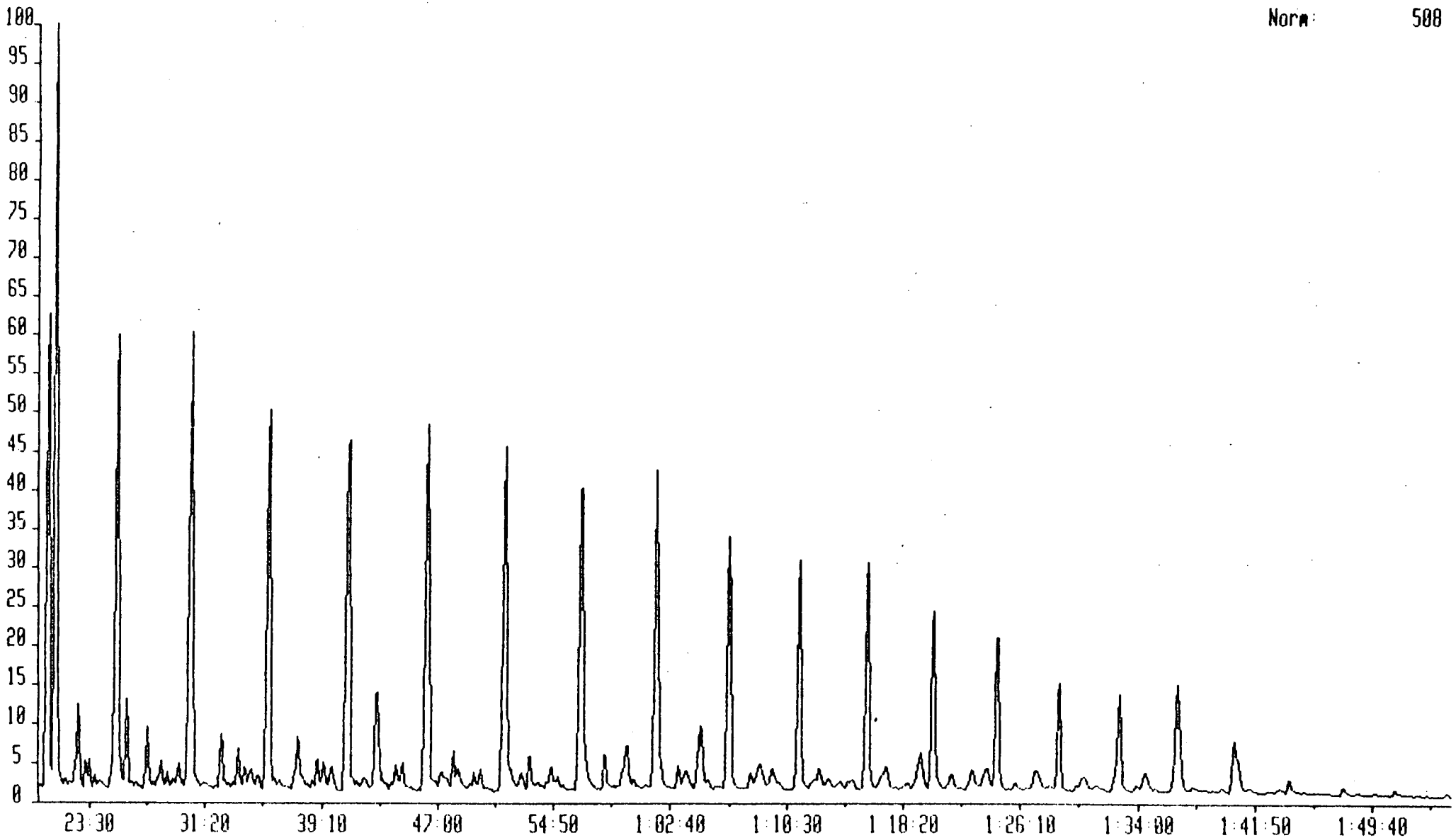
HIGH RESOLUTION MASS FRAGMENTOGRAMS

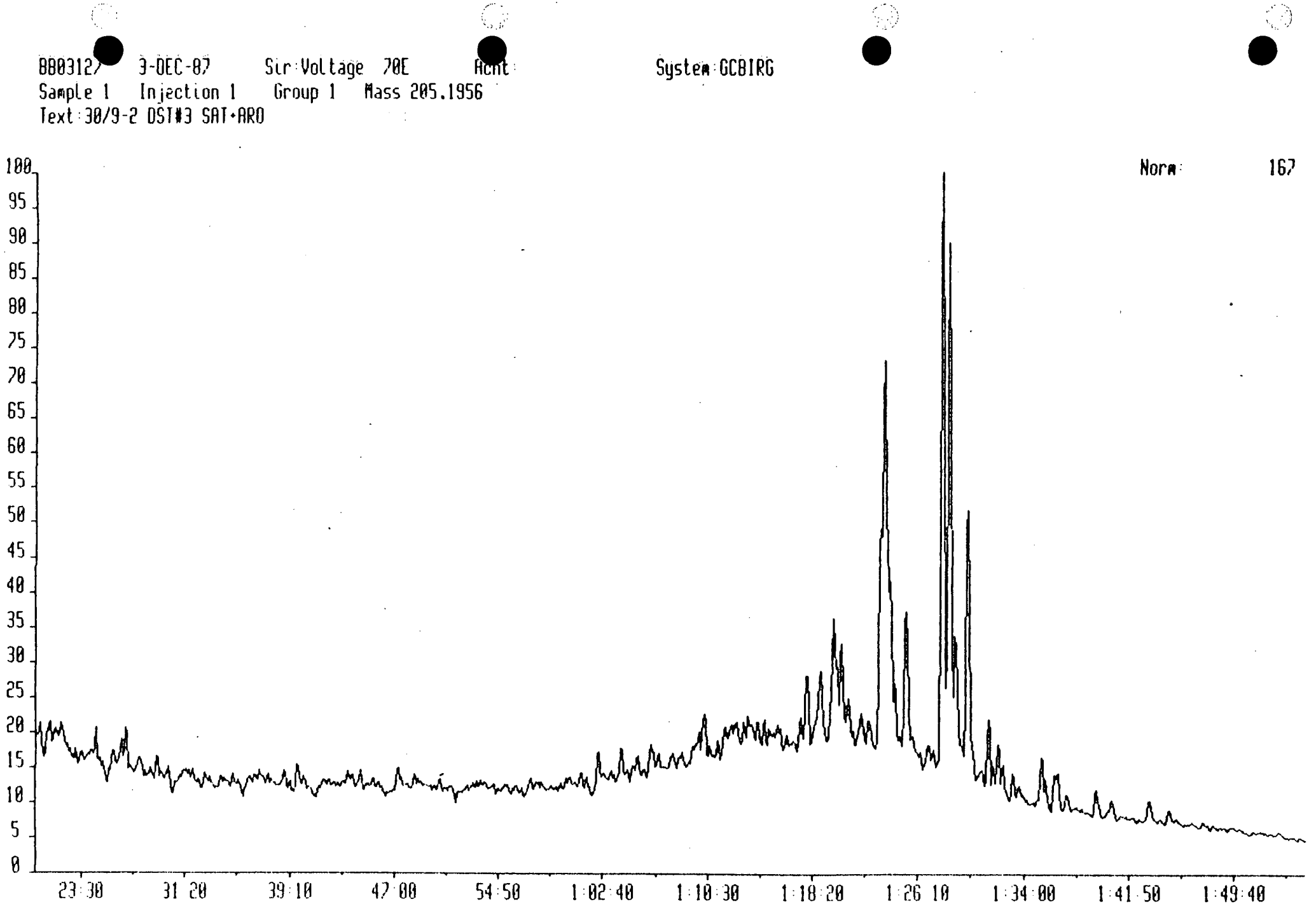
WELL 30/9-2 DST 3

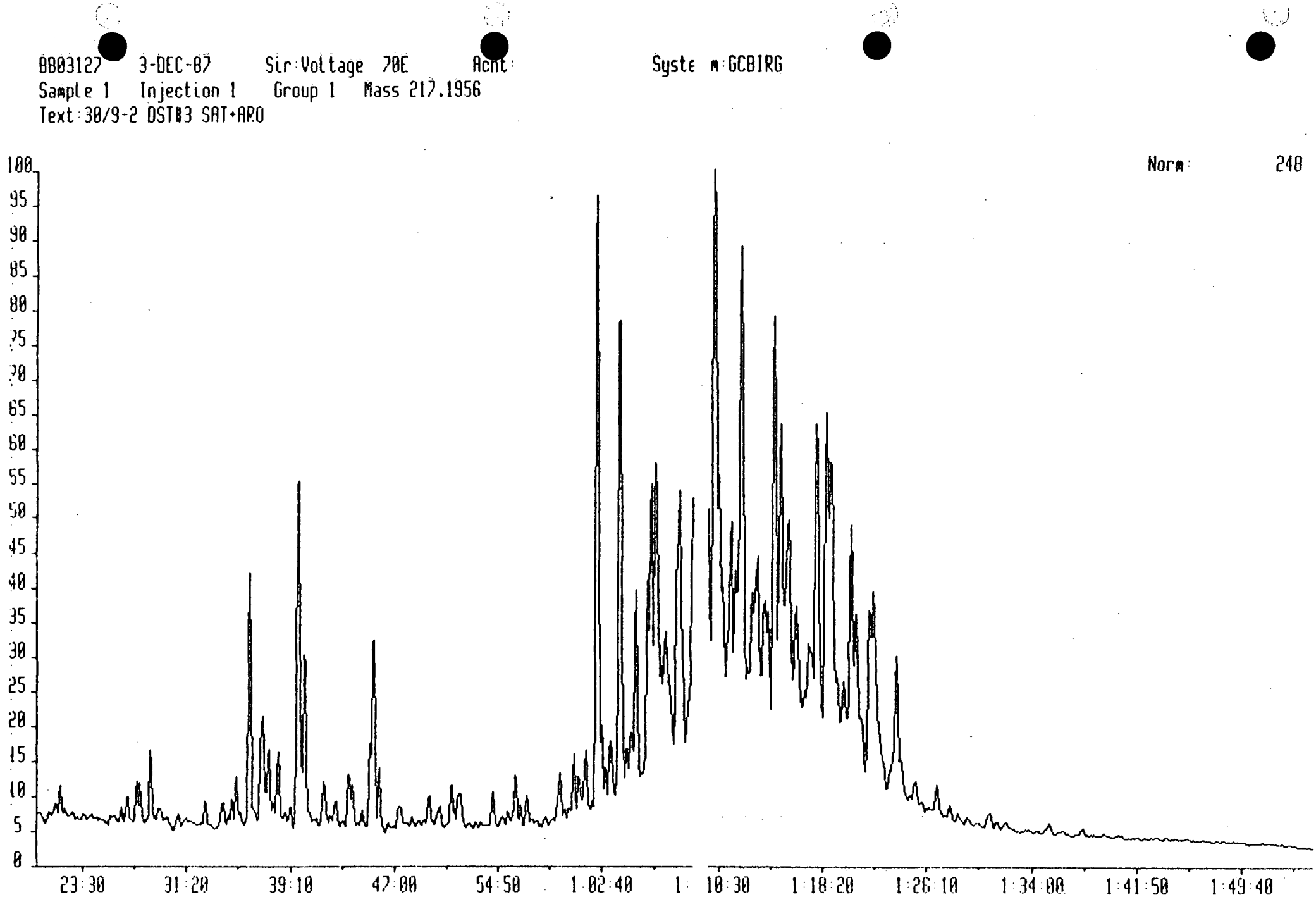

BA03127 3-DEC-87 Str Voltage 78E Acnt System GCBIRG
Sample 1 Injection 1 Group 1 Mass 177.1643
Text 30/9-2 DST 3 SAT+ARO
Norm
23 30
39 10
47 00
54 50
1 02 40
1 10 30
1 18 20
1 26 10
1 34 00
1 41 50

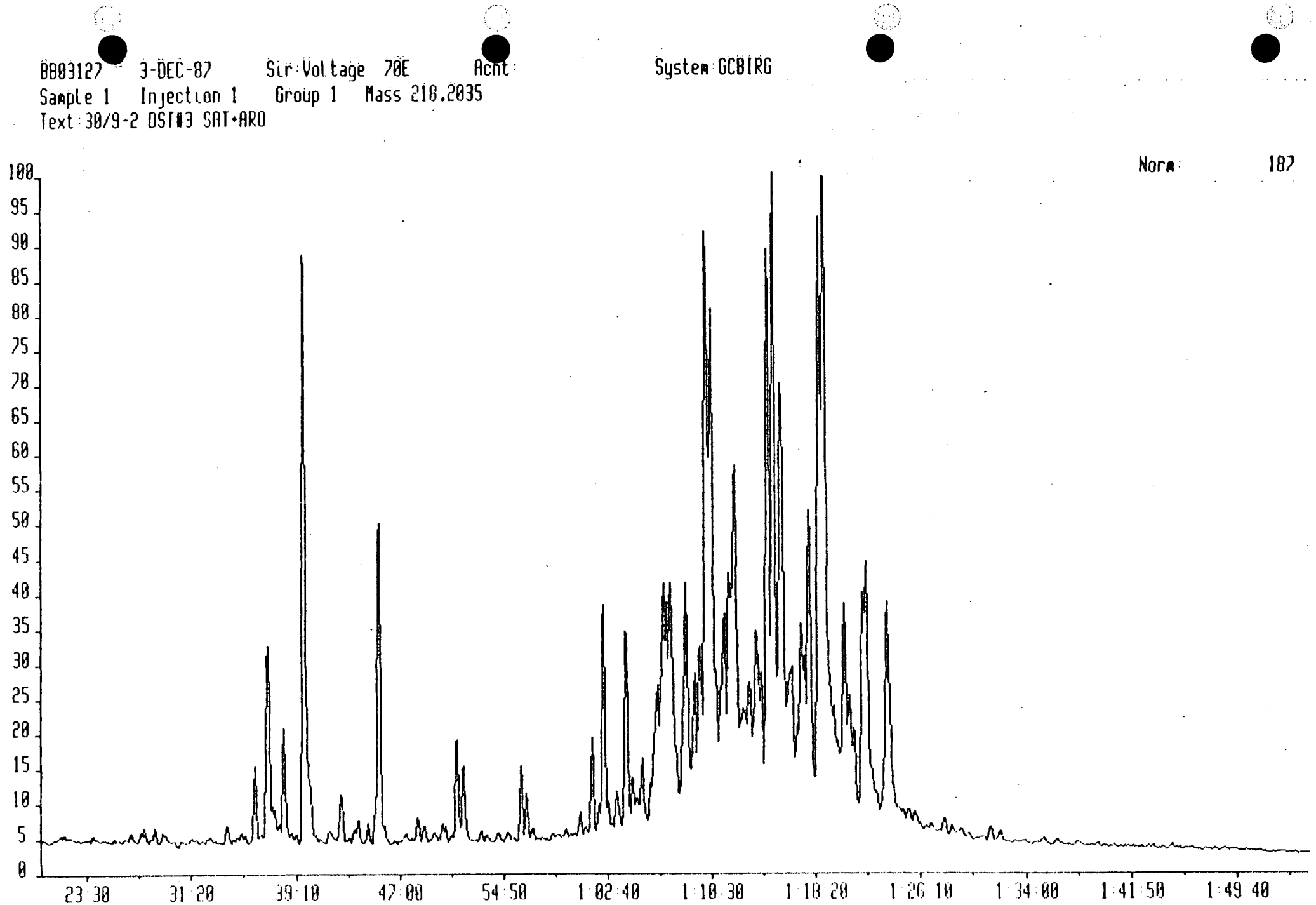

B803127 3-DEC-87 Scr Voltage 70E Acnt System GCBIRG
Sample 1 Injection 1 Group 1 Mass 191.1000
Text 30/9-2 DST#3 SAT+ARO
Norm 1416
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
23:30
31:20
39:10
47:00
54:50
1:02:40
1:10:30
1:18:20
1:26:10
1:34:00
1:41:50
1:49:40

BB03127 3-DEC-87 Sir Voltage 70E Acnt: System GCBIRG
Sample 1 Injection 1 Group 1 Mass 197.2269
Text 30/9-2 DST#3 SAT+ARO

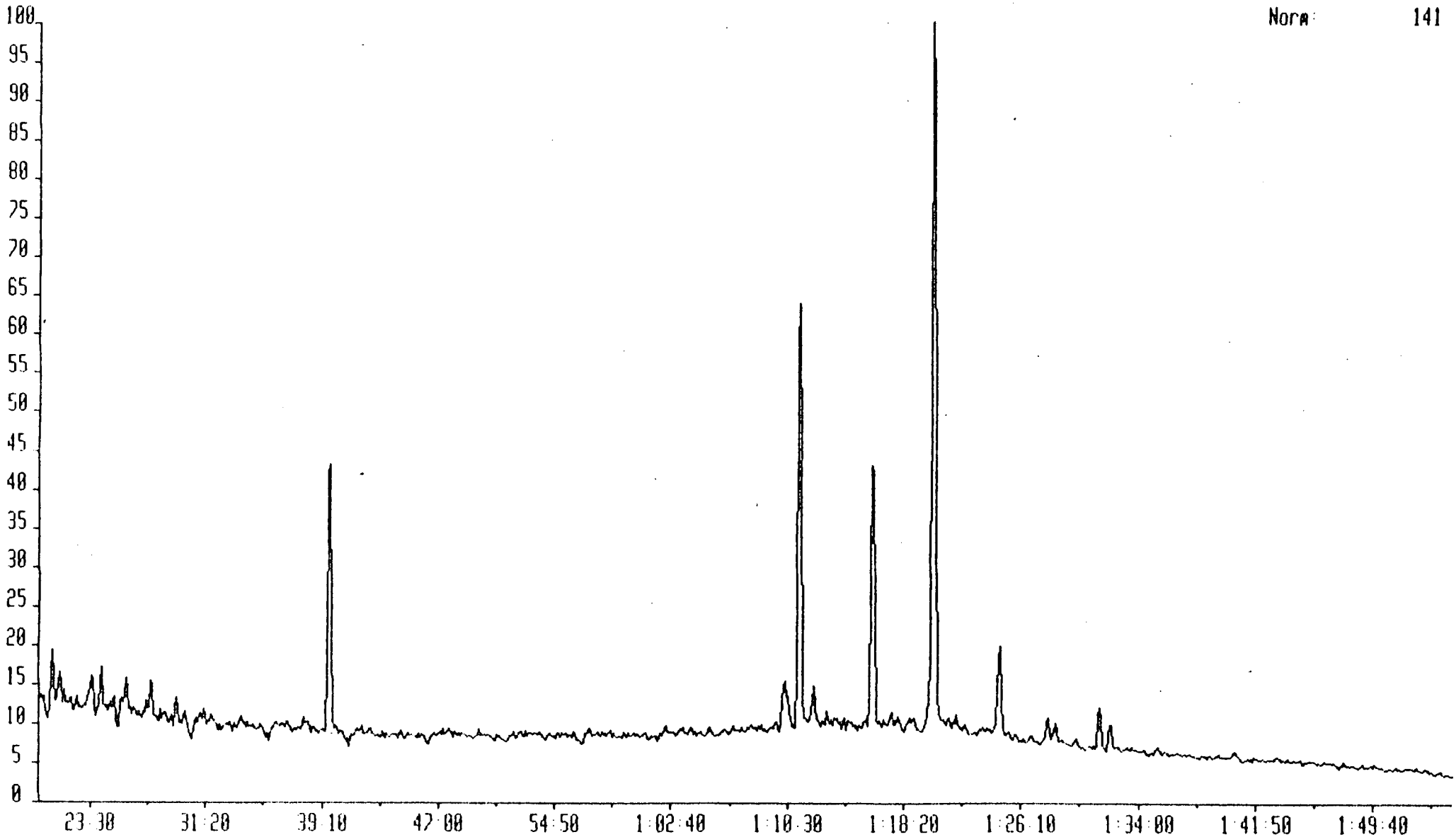



880312?
3-DEC-87
Sir Voltage 70E
Acnt
System GCBIRG
Sample 1 Injection 1 Group 1 Mass 205.1956
Text 30/9-2 DST#3 SAT+ARO
Norm 167
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
23 30
31 20
39 10
47 00
54 50
1 02 40
1 10 30
1 18 20
1 26 10
1 34 00
1 41 50
1 49 40

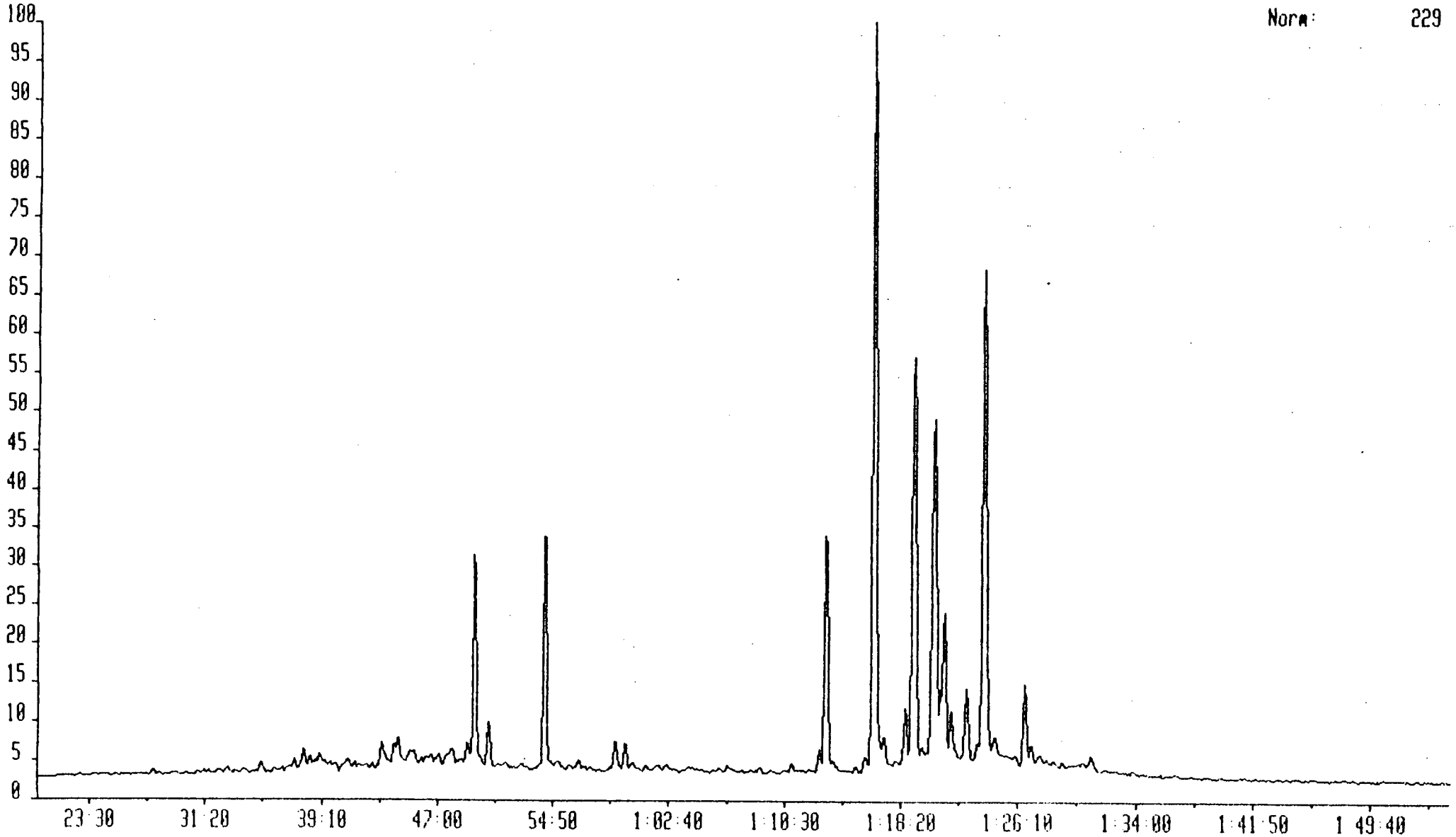

8803127 3-DEC-87 Sir Voltage 70E Acnt: Syste m GCBIRG
Sample 1 Injection 1 Group 1 Mass 217.1956
Text 30/9-2 DST#3 SAT+ARO
Norm 240
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
23 30
31 20
39 10
47 00
54 50
1 02 40
1 10 30
1 18 20
1 26 10
1 34 00
1 41 50
1 49 40

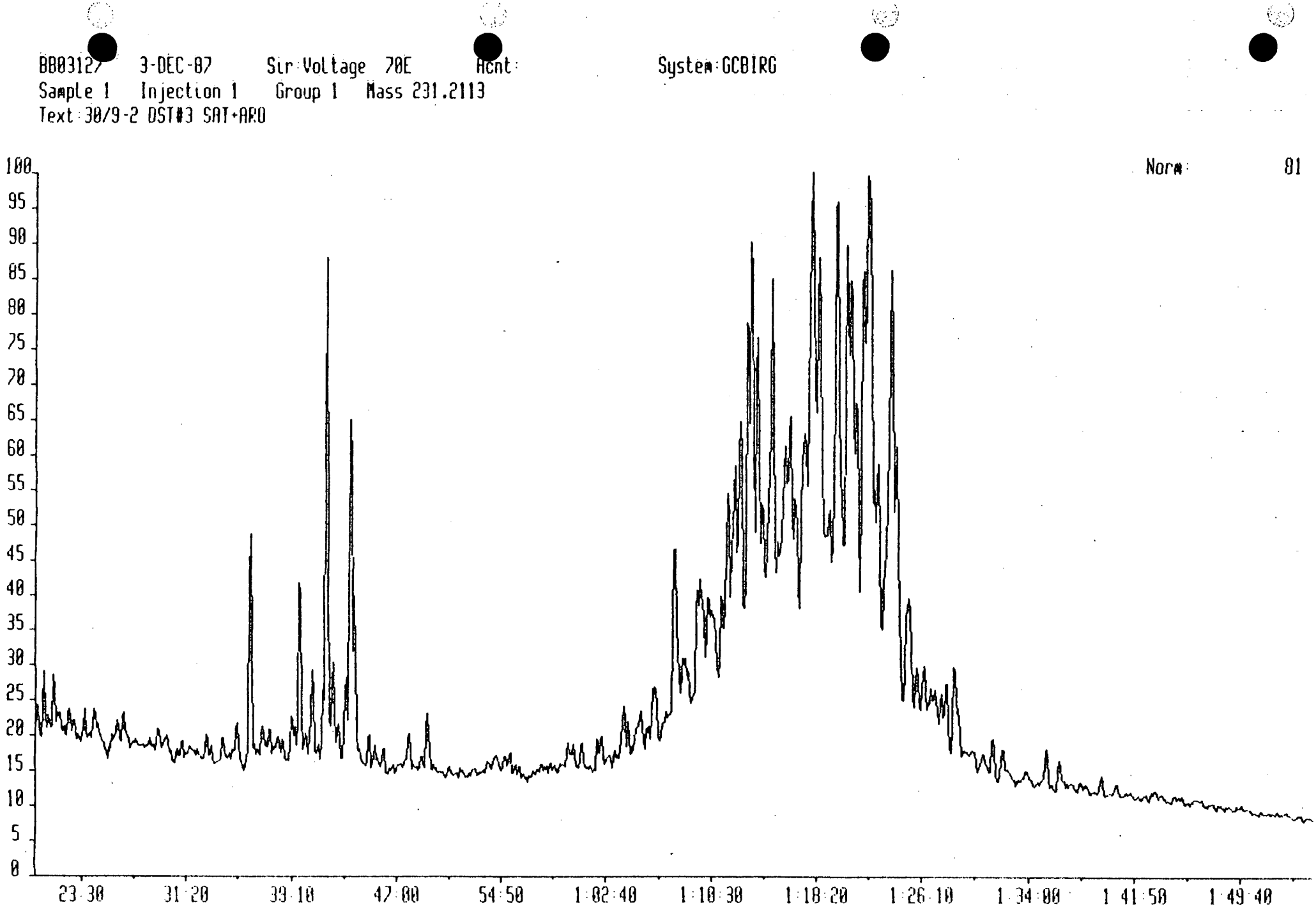

BB03127 3-DEC-87 Str Voltage 70E Acnt System GCBIRG
Sample 1 Injection 1 Group 1 Mass 218.2035
Text 30/9-2 DST#3 SAT+ARO
Norm 187
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
23 30
31 20
39 10
47 00
54 50
1 02 40
1 10 30
1 18 20
1 26 10
1 34 00
1 41 50
1 49 40

BB03127 3-DEC-87 Str Voltage 70E Acnt: System GCBIRG
Sample 1 Injection 1 Group 1 Mass 221.2208
Text 30/9-2 DST#3 SAT+ARO

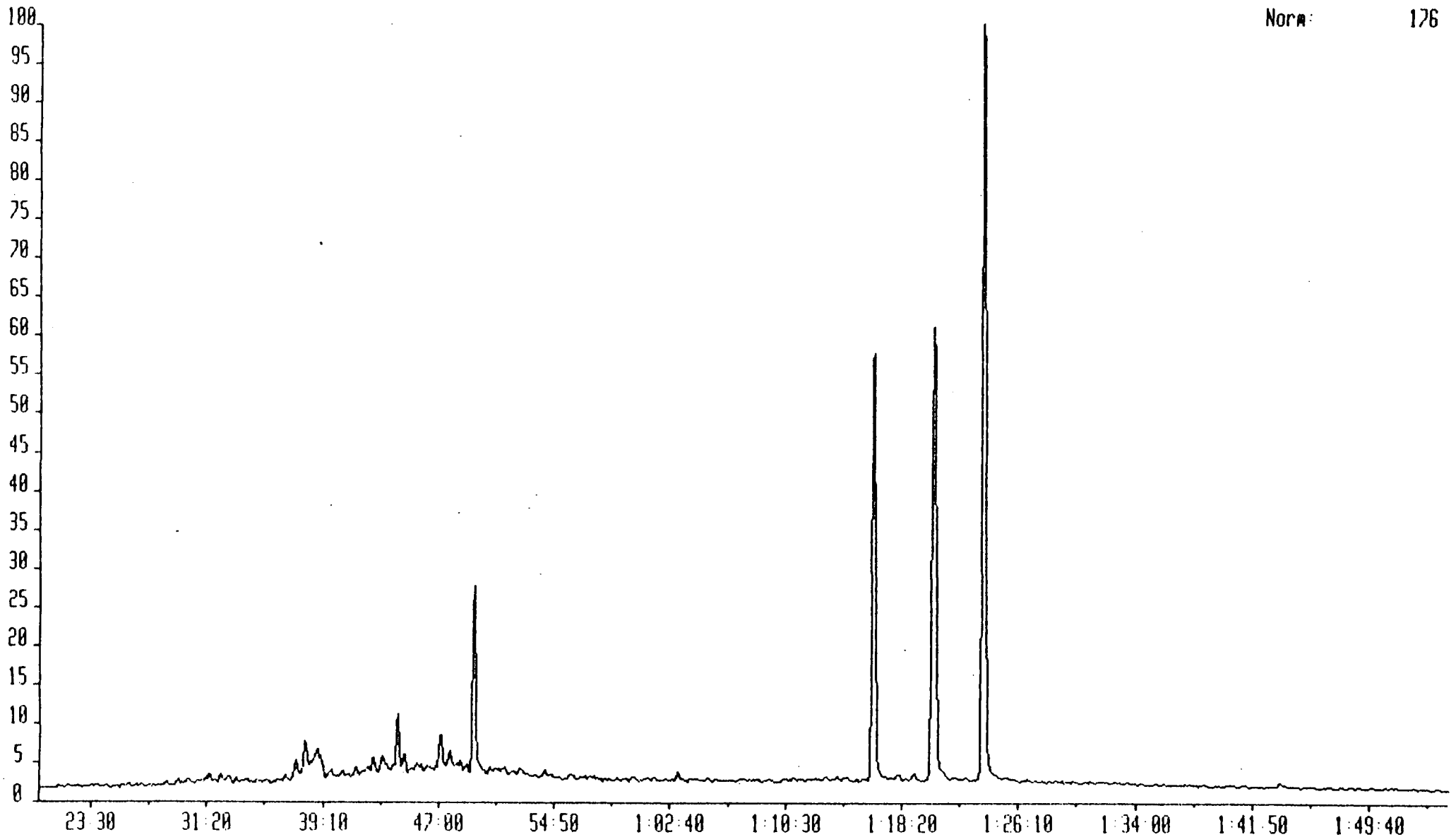


BB0312? 3-DEC-87 Str Voltage 70E Ment System GCBIRG
Sample 1 Injection 1 Group 1 Mass 231.1174
Text 30/9-2 DST#3 SAT+ARO

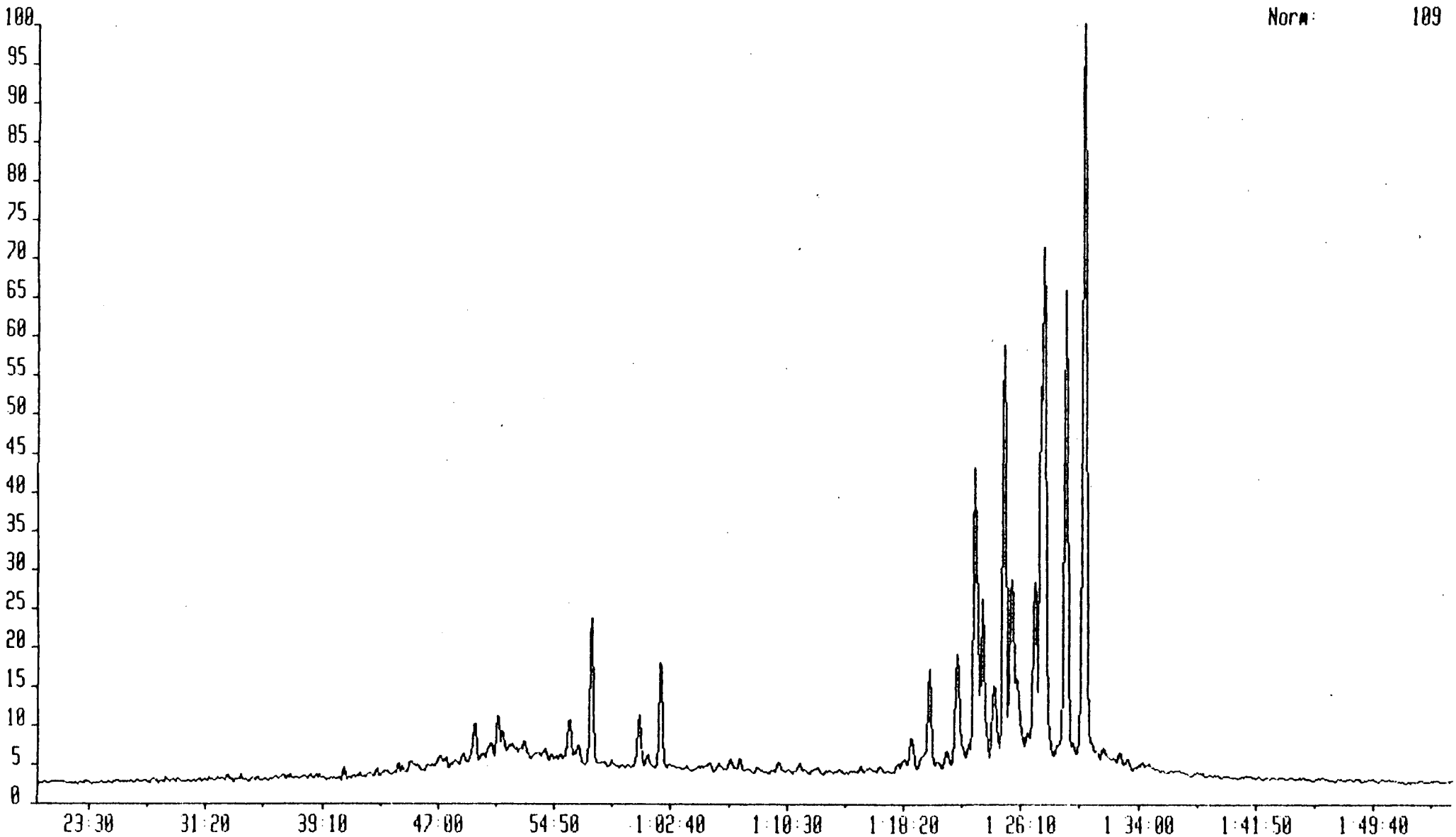


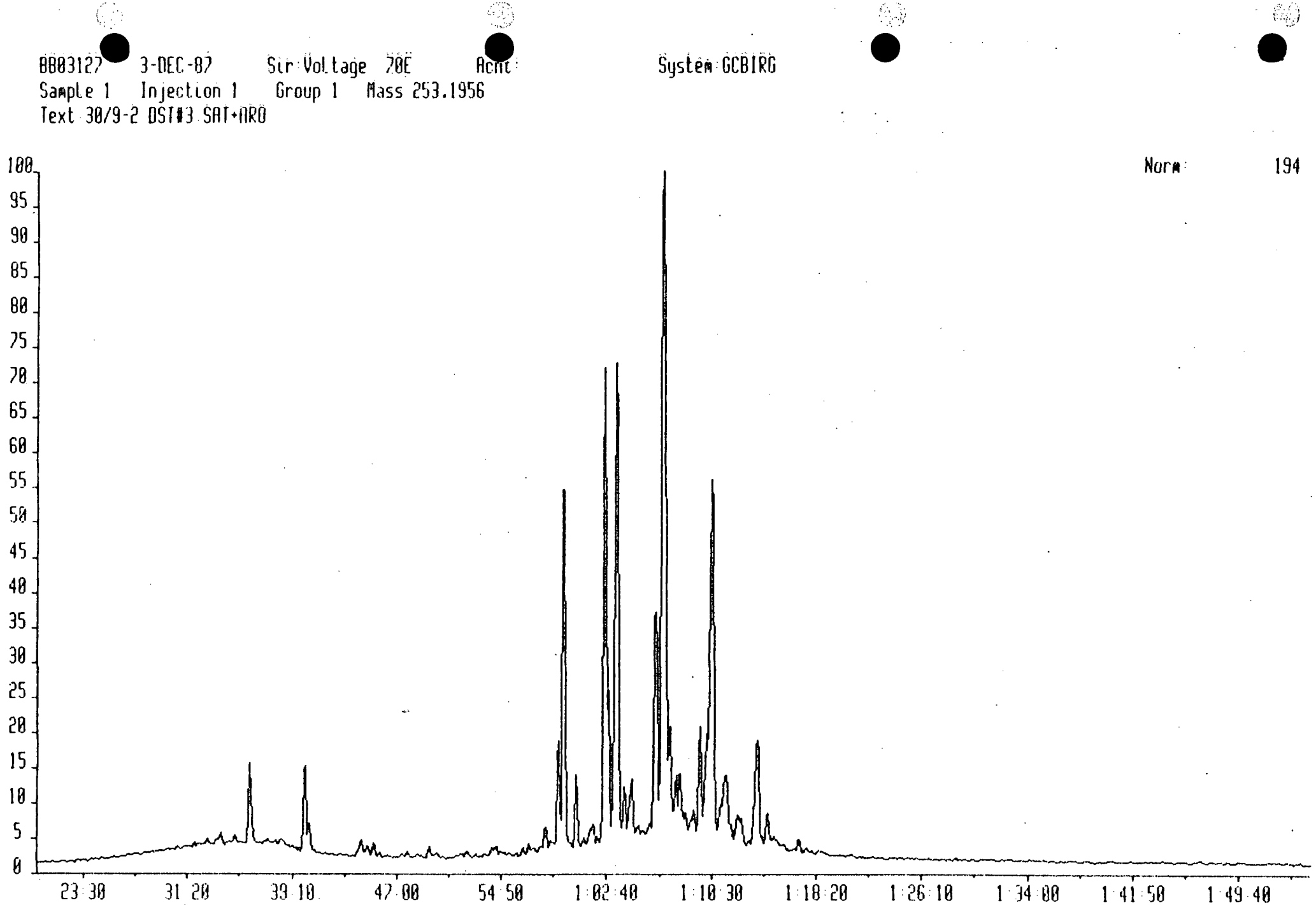

BB03127 3-DEC-87 Str Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 231.2113
Text 30/9-2 DST#3 SAT+ARO
Norm 81
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
23:30
31:20
39:10
47:00
54:50
1:02:40
1:10:30
1:18:20
1:26:10
1:34:00
1:41:50
1:49:40

BB03127 3-DEC-87 Str Voltage 70E Acnt System GCBIRG
Sample 1 Injection 1 Group 1 Mass 233.1299
Text 30/9-2 DST#3 SAT+ARO

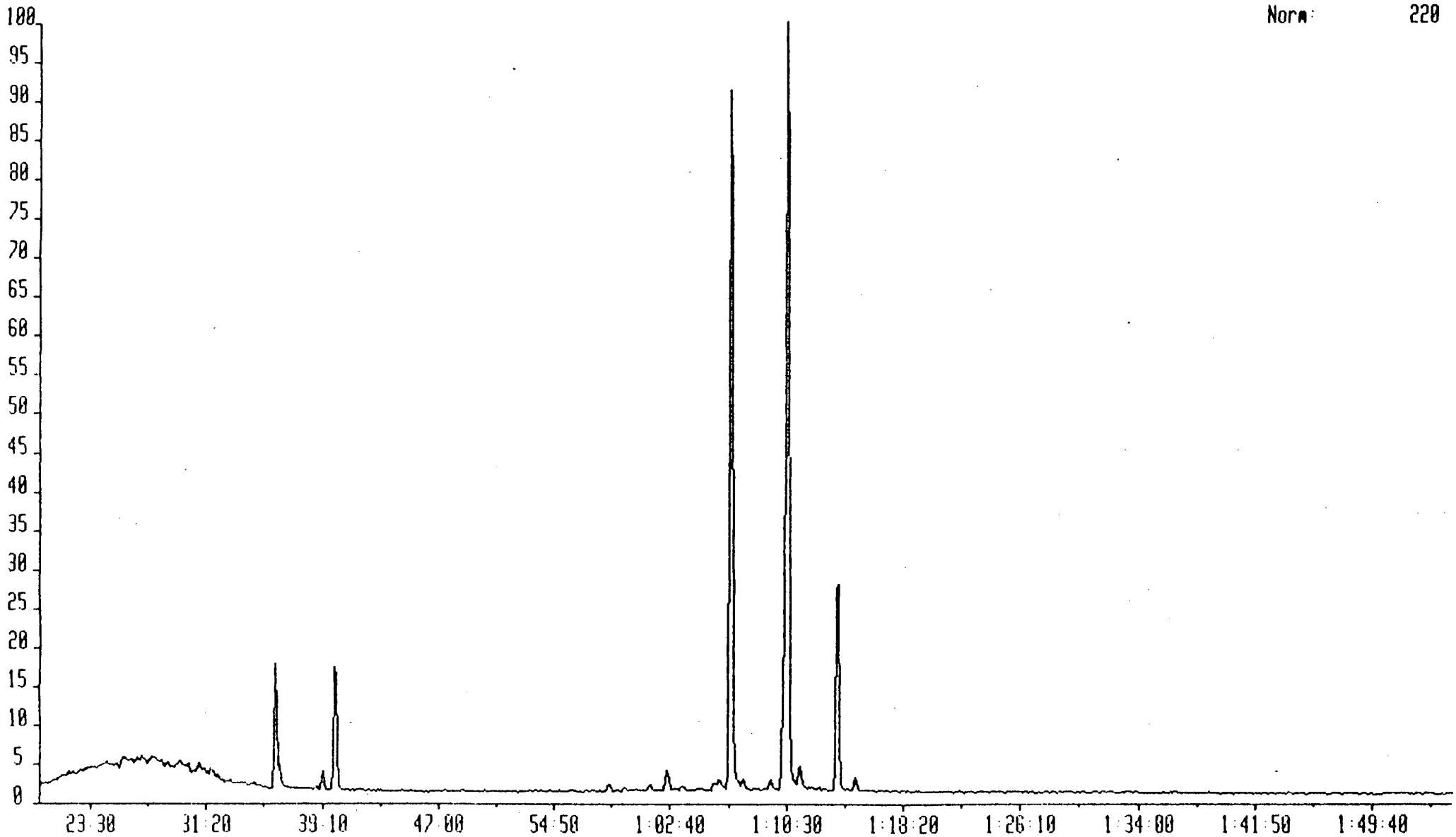


BB03127 3-DEC-87 Str Voltage 70E Acnt: System GCBIRG
Sample 1 Injection 1 Group 1 Mass 245.1330
Text 30/9-2 DST#3 SAT+ARO




BB03127 3-DEC-87 Str Voltage 70E Acnt System GCBIRG
Sample 1 Injection 1 Group 1 Mass 253.1956
Text 30/9-2 DST#3 SAT+ARO
Norm 194
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
23 30
31 20
39 10
47 00
54 50
1 02 40
1 10 30
1 18 20
1 26 10
1 34 00
1 41 50
1 49 40

BB03127 3-DEC-87 Str Voltage 70E Acnt: System GCBIRG
Sample 1 Injection 1 Group 1 Mass 256.2145
Text 30/9-2 DST#3 SAT+ARO



B803127 3-DEC-87 Scr Voltage 70E Acnt: System:GCBIRG
Sample 1 Injection 1 Group 1 Mass 259.2426
Text:30/9-2 DST#3 SAT+ARO